

NUTS & VOLTS

MAGAZINE

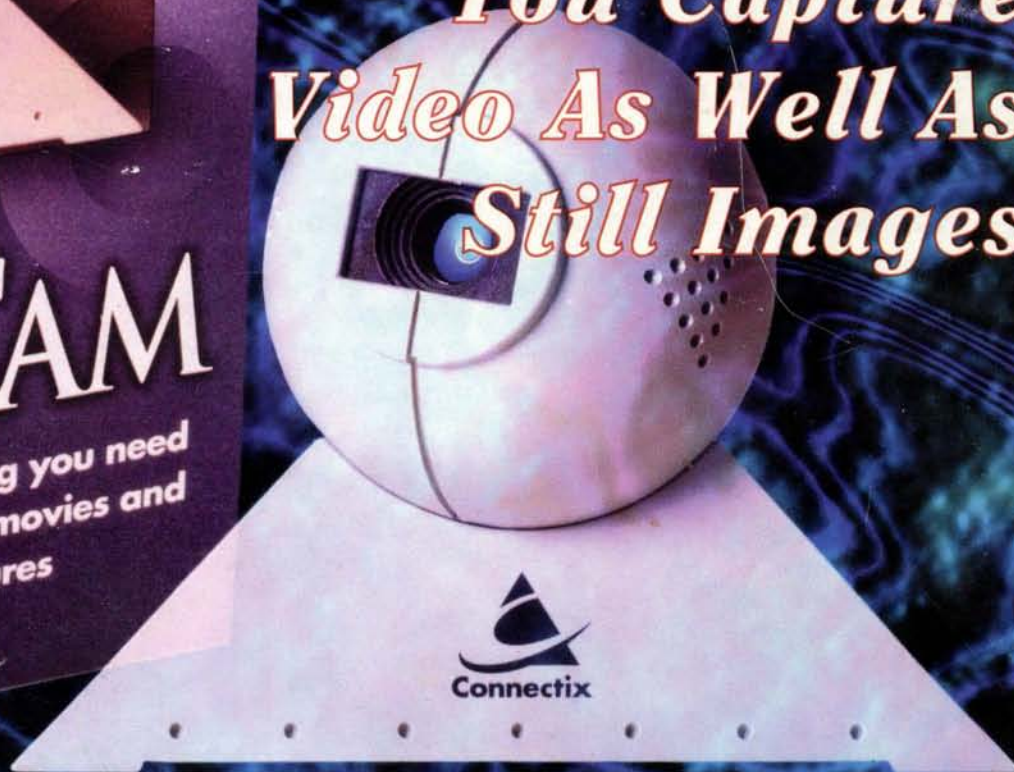
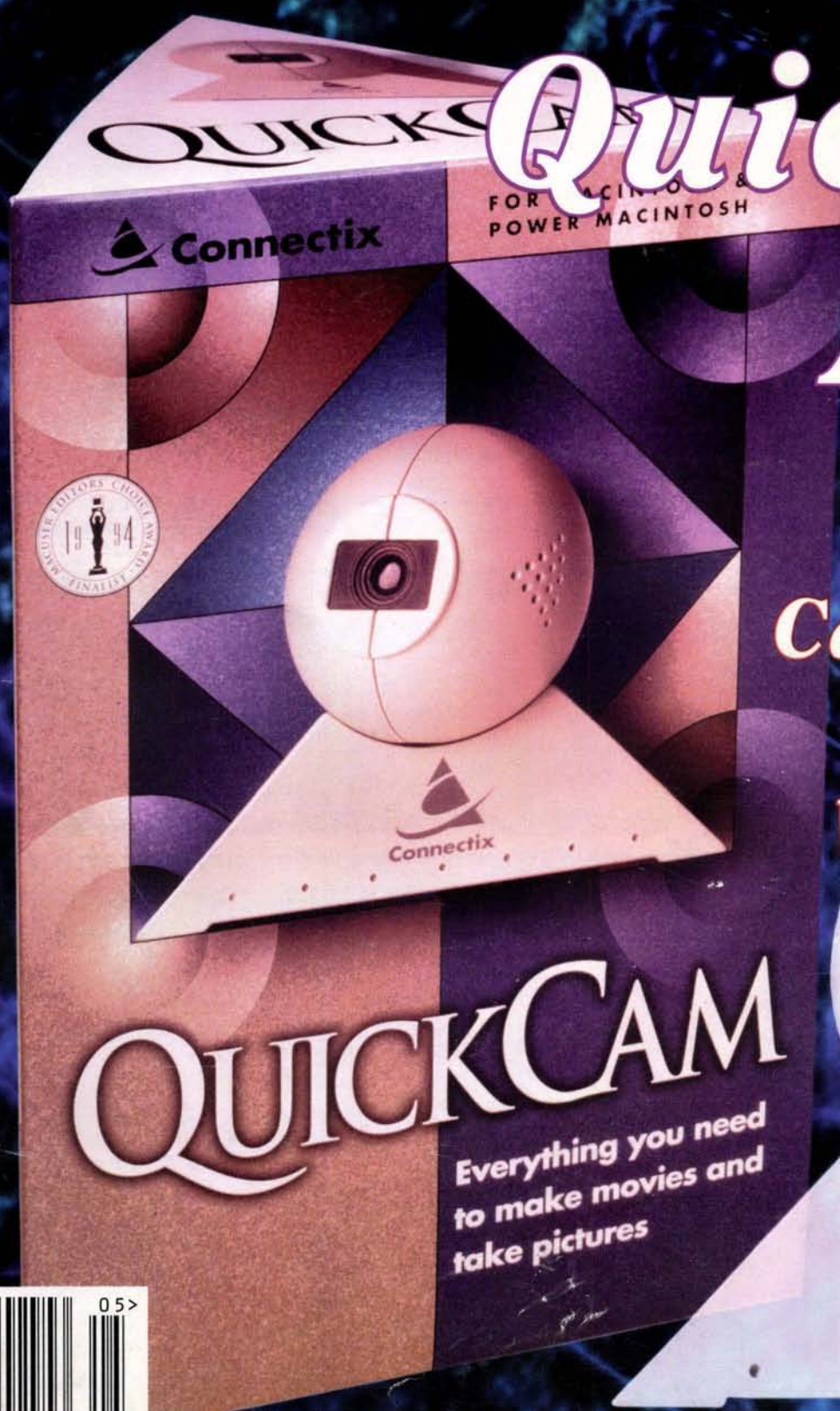


\$3.50
VOL. 17 NO. 5
MAY 1996

Exploring Electronics And Technology For The Hobbyist And Professional

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The New TDS 300 Series Digital Real Time Oscilloscopes offer more scope for your money!

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Capture real-time signals on each and every sweep with the new TDS 300 Series Digital Real Time Oscilloscopes — with twice the bandwidth and twice the sample rate of previous TDS 300 models. All models come with Fast Fourier Transform (FFT) to display harmonic content of waveforms. In addition, the TDS 360 and 380 come with a built-in floppy disk drive for simplified PC compatibility. These digital scopes will meet your needs in all areas: education, product design, manufacturing, service and troubleshooting.

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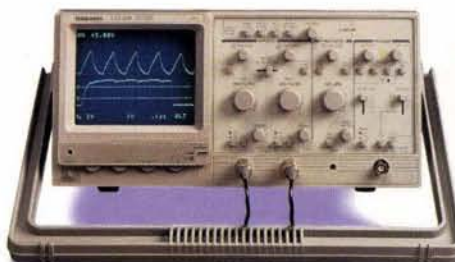
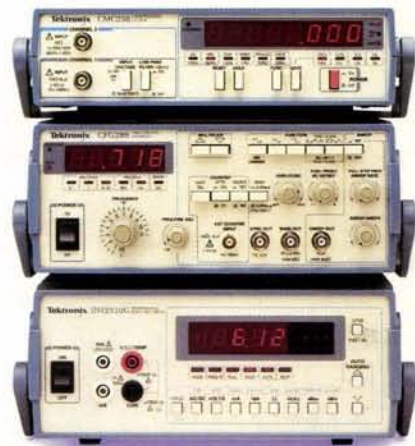
Compact, rugged and autoranging, this line of DMMs gives you Tektronix performance and reliability — in the field, at home or at the bench. When your work demands include troubleshooting electronics circuitry, adjusting and calibrating products, and checking components, our full line of DMMs offers the measurement capabilities to solve your problems. TekDMM features range from AC and DC volts and current to resistance and frequency. All TekDMMs come with a three-year warranty.

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 - Consists of new external Reno CD-ROM drive, docking bay with SCSI2 port, AC Adapter
 - Now with Macintosh installation software!
 - Double-speed 180ms drive is lightning fast!
 - Drive detaches from docking bay, use with headphones as a portable personal audio CD player
 - Great for Mac or IBM (adaptor bracket included)
 - Brand new in box, 90-day warranty

Media Vision Reno Kit HSC#15586

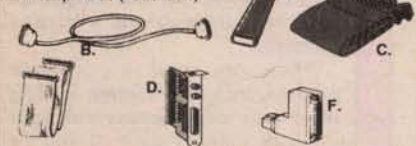
\$99.95



Reno detaches from
SCSI2 Docking Bay for
Complete Portability!

Media Vision Reno Kit HSC#15586 includes:

- Rechargeable Battery Pack
- Reno Cable Kit (SCSI2 - DB25 cable, 50p. ribbon cable, internal & external audio patch cables)
- Padded Travel Pouch
- Internal SCSI IDS50 to DB25 Adapter bracket for IBM, use with Reno cable kit (above) & your SCSI card for convenient SCSI and audio connections
- Headphones (not shown)

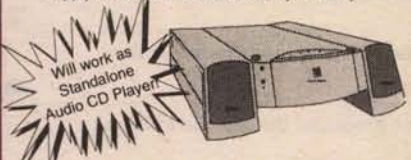


Reno Accessory Available Separately:

- Macintosh Powerbook SCSI Adapter (HDI-30 to 25-pin D connector) HSC#15704 \$12.50 if purchased alone, or with purchase of Reno Kit, \$5.00

Multimedia with Bose!

- Media Vision **Memphis** Kit (Limited Quantities Available)
 - Drive unit consists of new SCSI double-speed drive, custom enclosure, and detachable Bose active speakers with 10W/Channel amplifiers.
 - Includes Pro-Audio Spectrum 16 SCSI sound card, with special interconnect cable.
 - MPC & MPC2-compliant, true 16-bit stereo sound
 - Midi ports and audio jacks on back, NEC CDR210 CD-ROM Drive has tray, does not need caddies.
 - Supports DOS, Windows 3.1, Sound Blaster and Ad-Lib, joystick and full-duplex MIDI, so it can run nearly all audio applications ever made for PC's!
 - Awesome sound from Bose speakers!
 - Comes with copies of instruction manual, power supply, installation software, 90-day warranty



Media Vision Memphis kit HSC# 15753 **\$159.95**

Bargain SCSI Sound Card

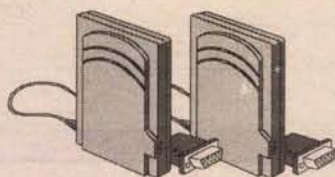
- Media Vision **ProAudio Spectrum 16** sound card
 - 16-bit audio, 44.1KHz stereo sound
 - MPU 401 MIDI emulation, Soundblaster compatible
 - Internal SCSI CD-ROM port, microphone jack (mike not included), line-in, speaker jack, joystick port
 - Includes driver disk, information sheet (no book)
 - OEM package (no box), 90-day warranty

HSC#15797 **\$39.95**

Wireless RS-232 Link!

- National Semiconductor's "AirShare" radio modules can link you up without RS-232 cables!
- Use with Laplink (or other link software) to network two computers over the serial ports (no software included)
- Works via 900 MHz radio frequency up to 30 feet (no line-of-sight requirements like infra-red links)
- Three user-selectable frequency channels for multiple units in the same room -- transfer rate up to 115Kbps
- Compact: each module measures 3.5" x 2.25" x .625"
- Units can be powered three ways:
 - 6VDC Wall Adaptor
 - Snap-on 9V Battery Compartment (2.25" x 1.75")
 - Mouse port "Power Thief" plugs in between mouse Mini-DIN connectors and "steals" power for unit
- Each kit includes:
 - Two AirShare modules for full duplex communication
 - One 6VDC Power Adaptor
 - Two 9V Battery Compartments (batteries not included)
 - One Mouse-port Power "Thief" with coil-cord
- Extra Power Adaptors available below

HSC# 15823 **\$49.95**



-- Extra Power Adaptors --

- 6VDC 150 mA Power Adaptor HSC# 15824 \$2.95
- Mouse Port Power "Thief" HSC# 15825 \$2.95
- 9V Battery Compartment HSC# 15826 \$.79

PCMCIA SCSI Card

- Media Vision PCMCIA SCSI II Card for Laptops
- Use with CD-ROM Drives, WORM Drives, Hard Drives, Scanners, any SCSI I or II device
- Bundled with Corel SCSI (ver. 2.04) software
- Cable, installation software, manual included
- Would make excellent laptop connection to Reno, above
- New in box with software, 90-day warranty

HSC# 15893 **\$79.00**

DTC Controller Riot!

- If you know computers, you know of Data Technology Corporation's reputation for robust device controllers!
- New in OEM packaging with Software & Info Sheet
- Many bus formats & drive types supported
- All have our 90-day warranty

DTC-2130 HSC# 15837 **\$19.95**

PCI Bus controller for two E-IDE drives (no FD)

DTC-2130D HSC# 15838 **\$29.50**

PCI Bus controller for four E-IDE drives (no FD)

DTC-3130 HSC# 15839 **\$59.00**

PCI Bus SCSI-2 Controller (no floppy drives)

DTC-3280AS HSC# 15840 **\$45.00**

ISA Bus 16-bit HD/FD SCSI Controller

Version 20.BIOS will control up to 4GB drives

DTC-3274 HSC# 15841 **\$95.00**

VLB SCSI-2 Bus-Mastering HD/FD controller

DTC-3150V HSC# 80376 **\$19.95**

8-bit Non-bootable SCSI (perfect for Reno!)

Cordless Mouse by BSR

- InfraRed Wireless Mouse frees you from tangles
- Transmits over 10 foot range
- Recharges in handy receiver base
- Three button design fits hand
- New in box, 90-day warranty
- Bus version for IBM
- Comes with adapter card, software, power supply and instruction manual

HSC# 15844 **\$24.95**

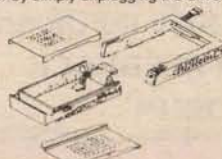
3-D SCSI-2 Sound Card

- Media Vision **Premium 3-D** high-quality sound card
 - 16-bit audio, 44.1KHz digitized stereo sound
 - MPU 401 MIDI, Soundblaster compat., SRS 3-D circuitry
 - Internal SCSI-2 CD-ROM port, microphone jack (mike not included), line-in, speaker jack, joystick port
 - Includes driver disks, photocopied book
 - OEM package (no box), 90-day warranty
- A few Wavetable add-on cards available - Call for info!

HSC#15842 **\$59.95**

Remove Your Drives!

- Make your 3.5" IDE or SCSI hard drives removable!
- Plastic docking bay mounts in 5.25" half-height slot
- Slide-out trays can be removed, swapped, stored, etc.
- Snap-on ventilated covers protect drives, electronics
- Key-lock feature improves security
- With the price of drives so low, backing up sensitive data was never so easy...or transport your data to another computer by simply unplugging the drive!



IDE Drive Docking Set HSC# 15819 **\$24.95**

Extra IDE Drive Tray HSC# 15818 **\$9.95**

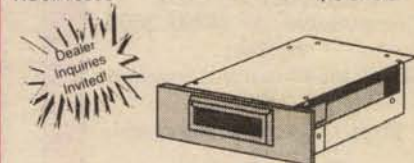
SCSI Drive Docking Set HSC# 15820 **\$24.95**

Extra SCSI Drive Tray HSC# 15821 **\$9.95**

Tape Backup Bargain!

- Irwin AccuTrak 31250A 250MB tape drives
- Brand new in box with 90-day warranty
- EZ-Tape software for DOS/Windows 3.XX is included
- Hooks to floppy controller with included insertion cable
- Comes with brackets and 5.25" faceplate for mounting in regular half-height drive bay, but can be mounted in 3.5" bay with optional faceplates below
- Made for IBM so you know it's rugged!

HSC#15805 **\$39.95**



-- Irwin Tape Backup Accessories --

Formatted 250MB Tape HSC# 15806 **\$9.95**

3.5" Faceplate, Light Gray HSC# 15807 **\$2.95**

3.5" Faceplate, Dark Gray HSC# 15808 **\$2.95**

Pentium Motherboards!

- New-in-box 66 MHz PCI Pentium Motherboard
- Four PCI Slots, Four 16-bit ISA Slots, uses 72-pin SIMM's
- ZIF Socket contains your choice of CPU, 60 or 66 MHz
- 256K Cache RAM installed, supports up to 1MB Cache
- PCI clock rates from 20 to 33 MHz supported
- User's manual included, ninety-day warranty
- New Lower Price for May! Hurry, supplies are limited

HSC# 15763 with 60MHz CPU **\$149.00**

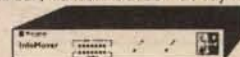
SCSI Drive Case Deal!

- Low-profile case for 5.25" drives
- Perfect for CD-ROM, hard drives
- 9.5" x 2.5" x 10.5" overall size
- 50-pin SCSI daisy-chain connectors
- Internal 50-pin cable, SCSI ID switch
- 35-watt power supply delivers 5VDC @ 2A, 12VDC @ 2A
- Used case has 90-day warranty, may need some screws

HSC# 15744 Low-Profile 5.25" Drive Case **\$24.95**

Network Hub for Less

- National Semiconductor's "InfoMover"
- 6-port 10BaseT Twisted Pair Ethernet Hub
- Measures 9" x 6" x 1.5"
- Perfect for workgroups, small office network systems
- New in box, manual included -- 90 day warranty



HSC#80387 **\$59.95**

Multimedia Combo-packs

- Your choice of double- or quad-speed Multimedia Packs
- Comes with Media Vision Prosonic 16 SCSI sound card, cables, installation software, unamplified speakers, ten CD titles, and internal Sanyo CD-ROM drive
- Utility software is DOS/Windows compatible, includes Pocket Mixer, Pocket Recorder, Pocket CD Player
- 10 CD's Included: Home Repair Reference Kit, Compton's 1995 Encyclopedia, Sports Illustrated 1994, Compuserve, Sim City 2000, Lenny's Music Tunes, The Legend of Krandia (Book Two), Cyberia--Mission Norway, Lunicus, Vroom Books for Kids
- Drives are tray-type (no caddy needed)
- OEM packaged (plain white box)
- 90-day warranty



Multimedia Kit with double-speed Sanyo Tray-type drive

HSC# 15827 **\$79.00**

Multimedia Kit with quad-speed Sanyo Tray-type drive

HSC# 15828 **\$119.00**

Optical Drive Jukebox Project

- Optical Drive Jukebox by International Data Engineering
- Set up for Panasonic drive, which is not included
- Changer mechanism stores and changes ten disks, and can be loaded or unloaded from front access slot
- Accepts 650MB, 1GB and 1.3GB optical disks
- SCSI Interface, software included
- Can be set up for other drives, including Maxtor, but will require fabrication of mounting brackets and alignment
- Installation manual includes alignment procedure
- Measures 12" x 12" x 18"
- New in box, 90-day warranty (if unmodified)



HSC#15773 **\$129.00**

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The closing date for each issue is the 10th of the prior month, e.g., the closing date for the June issue is May 10th. Ad copy to be typeset by Nuts & Volts should be received one week prior to the closing date.

Call or write for current advertising rates.

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EDITORIAL CONTRIBUTIONS

Nuts & Volts Magazine encourages article submissions and queries. Send a SASE for a copy of our writer's guidelines.

All submissions should be on 5-1/4 or 3-1/2 inch diskettes and include hard copy as well. If return of materials is requested, include a SASE with your submission.

Deadlines should be discussed in advance with the editor, but generally all material should be submitted by the 1st of the month for the next month's issue.

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If you are moving, notify us AS SOON AS POSSIBLE so we can continue your subscription without interruption.

Your magazine WILL NOT automatically be forwarded to you by the post office, so it's important to submit your change of address directly to Nuts & Volts.

We will not be able to replace missed issues of the magazine due to unreported address changes.

When you send in your new address, include a current mailing label from the magazine with your account number on it. If you do not have a mailing label, be sure to include your old address and the name(s) under which the subscription was submitted.

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reader FeedBack

Dear Nuts & Volts:

I recently ran across an ad in your magazine selling computer viruses. My company services PC systems in all phases, including: Building, installing, and administration of Novell networks. We support large and small companies.

With the ever growing problems with computer viruses, I was very surprised and offended to see this particular advertisement. You have no idea how many production hours are lost daily due to viruses. In long term, each and every one of us are paying the price for this ongoing and ever growing attack on information storing PC systems just as if it were an added tax. As you well know, all companies pass on their overhead cost to the consumer to maintain their margin of profit.

Looking past the initial profit that you receive for publishing this ad, you are assisting every American tax paying adult by increasing their cost of living with this "hidden" added cost of paying for down time, diagnostics, and repair of these systems.

I would very much appreciate you taking the time to reconsider your publication supporting the illegal contamination of private and public PC systems.

Gerald Barnhardt
Kannapolis, NC

Editor's reply:

Because advertisements dealing with computer viruses appear in Nuts & Volts, does not mean, by any stretch of the imagination, that we "support the illegal contamination of private and public PC systems," any more than use of the internet means that you support on-line pornography, home-made bomb making, or any other topic that might have information available there, whether you yourself use it or not. If someone advertises a product that has legal uses, but CAN be used illegally, it is the end users responsibility to obey the laws governing the product.

Obtaining information about viruses for the purpose of understanding how they work, safeguarding against an infestation of ones own system, developing a new anti-virus program, or just plain curiosity do not constitute a violation of any laws that I am aware of.

I'm sure that I'll catch a lot of flack for not taking the absolute moral highground and doing what I can to stamp out possible evil when it is within my power to do so.

It is virtually impossible for a

publisher such as us, to tell from the face of an ad, what someone intends to do with an advertised product or what the intended use of the product is.

We do not print articles condoning, instructing, encouraging or justifying illegal activities regarding electronics. However, we do not shoulder the responsibility of evaluating the products advertised, based on the possibility that they MIGHT be used illegally.

The burden of having to be the judge, jury, and policeman of the electronics industry is beyond the scope of one small publication.

That's for a higher authority.

Editor

Dear Nuts & Volts:

Wow, am I excited! On page 49 of the Apr. '96 issue of Nuts & Volts there is an editor's reply that says (talking about events calendar); "If the more detailed version was viewable . . . at our Web site, would that be an acceptable compromise?"

Web site? Web site? Is there a secret Nuts & Volts Web site?

I looked on the Events Page, I checked the masthead and contents page, but no URL for a web site was listed. I scanned the magazine cover to cover, and although I found lots of advertiser Web sites, I didn't see any marked "Nuts & Volts."

Is the Web site a secret, as in Top Gun, and now you have to kill everyone who read page 49? Do you have to know a special hand shake, or knock on a virtual door and say "Larry sent me," through a tiny virtual window?

Has Nuts & Volts finally come into the future with a real Internet connection, rather than just an E-Mail account through CompuServe?

Was "Editor" (how come these folks never use their real name) just dreaming about a glorious Star Trek like future, with online schematics (darn spell checker is off-line), expanded sidebars with links to the supplier's Web sites, and video clips of how the projects actually work when you build them correctly?

Or was this a slip of the editor's keyboard?

I almost forgot, I agree with J.G. Owen on page 49. The for profit computer shows should be charged a fee to help pay for the extra pages. The Hamfests and shows with no admission fee should get expanded space.

A.J. Byrnes

Editor's reply:

Wow! We're excited too. See page 105 for the Web site latest.

Editor

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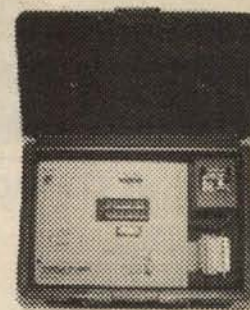
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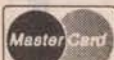
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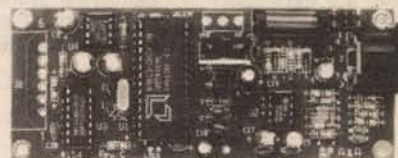
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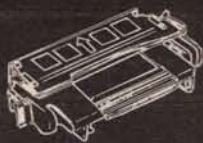
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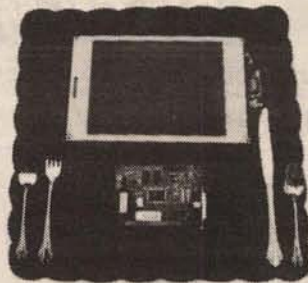
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Part 1

Understanding and Using A/D Converters

Like the omnipresent op amp, the 12-bit sampling ADC has become a staple of our industry. I'll show you how they work, and how to put them to work.

While gift shopping at the mall last week, I had an opportunity to browse several stores and was surprised to see just how dependent today's consumer products have become on digital circuitry. I found microcontrollers in everything from air conditioners to microwave ovens, digital signal processors (DSP) for sight and sound, and lots of custom digital chips to tackle assorted other tasks like running a blender or monitoring blood pressure.

But the more I looked, the more apparent it became that through it all there was one underlying theme: While the "brains" of these devices are digital in nature, we live in an analog world where things are measured by the inch and the pound. In other words, every item I saw has to have a built-in language translator that converts real-world values like time and temperature into binary ones and zeros.

The Rosetta Stone used for this process is a circuit called an analog-to-digital converter, or ADC. Until recently, though, ADCs were expensive, hard to use, and terribly under powered. Thankfully, technology changes, coupled with increased supply and demand, have changed all that. Much like the op amp, the 12-bit ADC has become a ubiquitous staple of our industry. In the following two articles, you'll learn all about this workhorse.

A Sampling Theory Primer

Before the invention of the integrated circuit, converting plowshares into electrical signals was done using motors and gears. Today's ADC does it using a voltage reference, a voltage comparator, a feedback circuit, and a digital output latch. This collection of parts includes circuits from several different walks of life. In fact, until just recently, the only way to accomplish this was to wire together modules from different technologies and seal them in a hybrid capsule. With today's new processing techniques, these diverse technologies can be fabricated on a single monolithic chip.

Key to the success of the 12-bit ADC is sampling technology — a method whereby high-frequency signals can be measured using low-cost electronics. Let's take the waveform in Figure 1(a), which shows how a sine wave is digitized in real-time. The trick is to take periodic voltage samples

of the waveform, process them one at a time, then chart the binary results which, when displayed on a spreadsheet or charting program, will reconstruct the original waveform.

Waveforms sampled in real-time are governed by the Nyquist criterion, which states that to accurately acquire a waveform, the sampling rate must occur at a frequency greater than twice the highest input frequency component. For example, a 500-KHz input signal must be sampled at 1 MHz to satisfy the Nyquist criterion. Several 12-bit ADCs feature sampling rates of 1 MHz and better.

However, if you're working with waveforms that are periodic in nature, like a sine wave, you can use a technique called equivalent-time sampling, or undersampling, to measure frequencies in excess of the Nyquist limit. Consider the example in Figure 1(b).

Each dot represents a voltage sample of the input signal, with each sample taken not from a single waveform, but from different points along consecutive input signal cycles. The result is a waveform that has exactly the same shape and amplitude as the original, but at a lower frequency. When working with this measurement in your software, you can easily correct the frequency to its original value using a simple multiplying algorithm.

Inside the ADC

A conspicuous trait of 12-bit ADCs is the nearly-exclusive use of successive approximation register (SAR) architecture in their design. The SAR technique is analogous to a jeweler's scale where you have two pans on opposite sides of a balance beam. The unknown weight, placed in one pan, is determined by successive trials with standard weights placed in the other pan. Depending on which way the scale tips, weights are added or subtracted, until a balance is reached where the unknown

weight equals the sum of the standard weights.

Central to SAR operations is a digital-to-analog converter (DAC) that generates an output voltage which is proportional to a digital code applied to its input. In effect, the DAC is the balance beam; it provides feedback (Figure 2) that tells the logic circuit when the input is equal to the output.

At the beginning of the conversion cycle, the logic circuit clears the shift register's latches, then sets the MSB (most-significant bit) high. This causes the DAC to output a voltage equal to half the reference voltage. The comparator then compares the unknown input voltage to

the output of the DAC to see which is higher. If the unknown voltage is less than the output from the DAC, the MSB latch is reset to zero; if it's higher

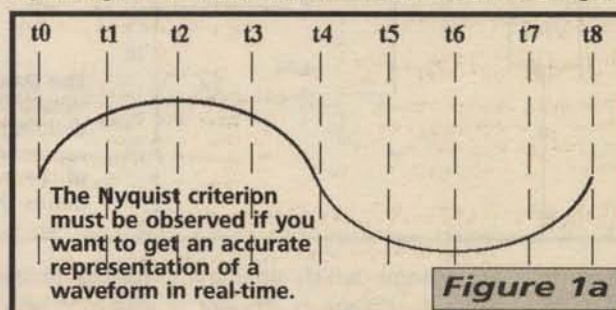


Figure 1a

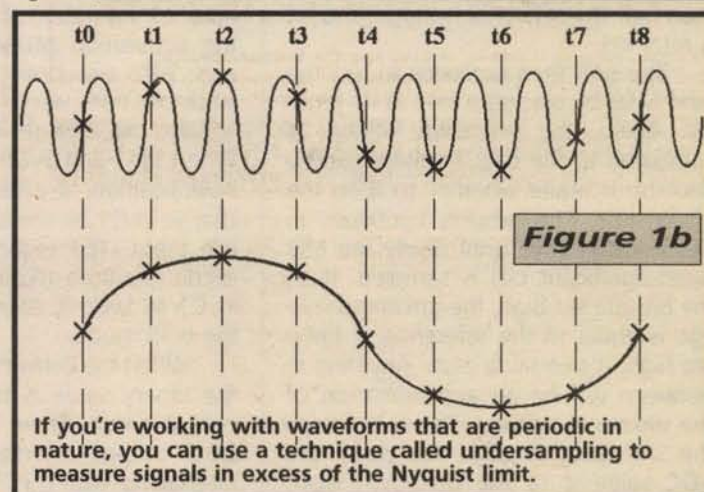


Figure 1b

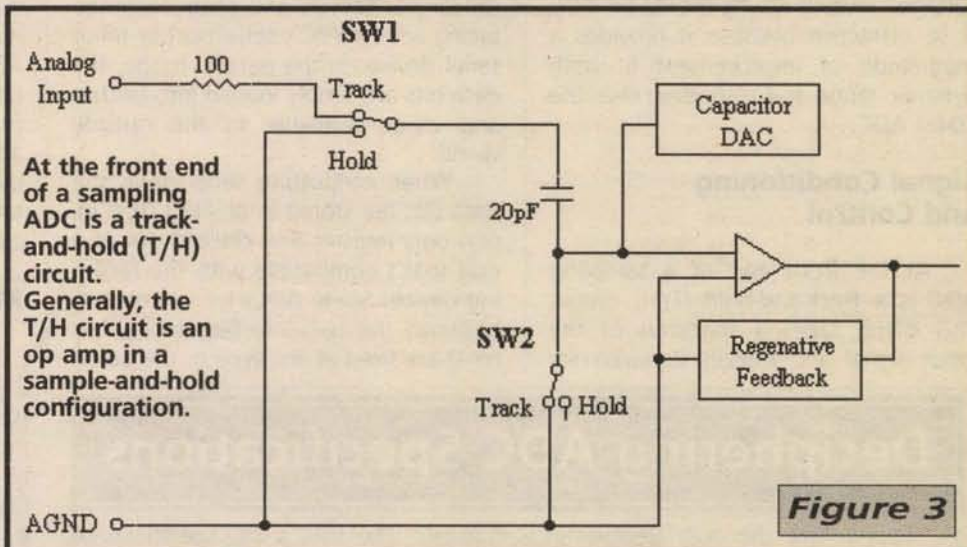


Figure 3

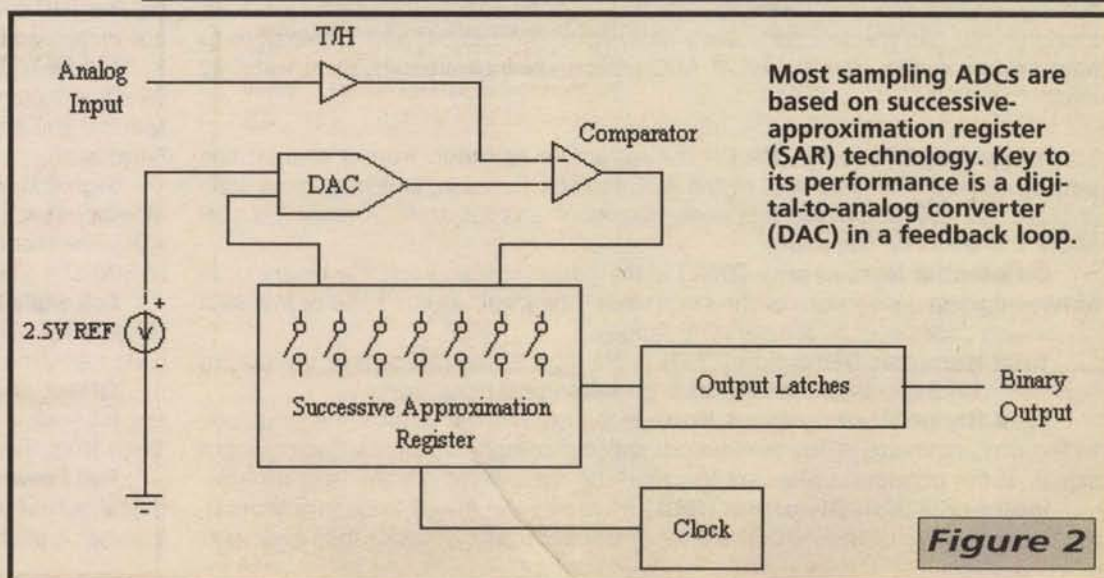


Figure 2

Most sampling ADCs are based on successive-approximation register (SAR) technology. Key to its performance is a digital-to-analog converter (DAC) in a feedback loop.

Reference Voltage

R/2R Ladder Converter

Output Amplifier

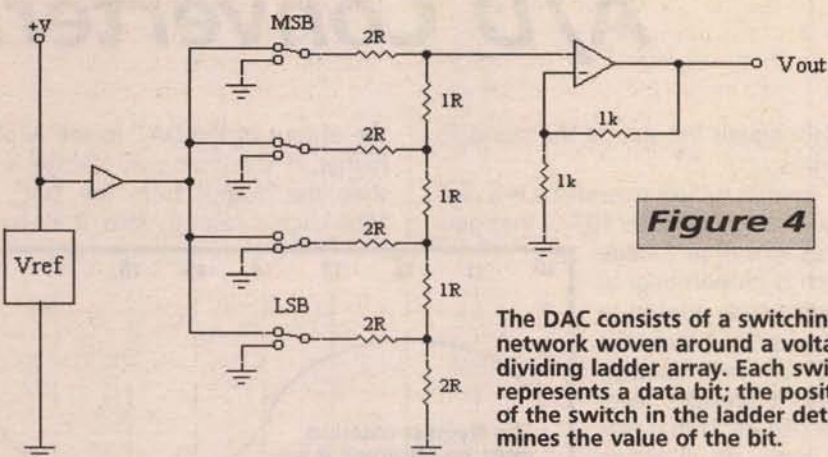


Figure 4

The DAC consists of a switching network woven around a voltage-dividing ladder array. Each switch represents a data bit; the position of the switch in the ladder determines the value of the bit.

than the DAC voltage, which signifies that the unknown voltage is greater than half the reference voltage, the bit is retained.

The SAR then proceeds to test the next MSB by placing a one in its register. Again, the unknown voltage is compared to the DAC's voltage, and a decision is made whether to keep the bit or not. The process continues in descending order until finally the LSB (least-significant bit) is sampled. If all the bits are set high, the unknown voltage is equal to the reference; if none are high, it's equal to zero. Anything in between will be an approximation of the unknown voltage. The more steps the SAR goes through, the closer the ADC value is to the unknown input voltage — which is why the 12-bit ADC is so attractive because it provides a magnitude of improvement in both dynamic range and resolution over the 10-bit ADC.

Signal Conditioning and Control

At the front end of a sampling ADC is a track-and-hold (T/H) circuit. This circuit takes a snapshot of the input signal and freezes its value for

further processing. Generally, the T/H circuit is an op amp in a sample-and-hold configuration (Figure 3). During the acquisition phase, switches SW1 and SW2 are both switched to the track position, which causes the input voltage to charge $C1$ through $R1$. When SW1 and SW2 are moved to the hold position, it effectively places the charge in $C1$ on the comparator's positive input. The regenerative feedback circuit monitors and adjusts the charge in $C1$ to keep it constant while it's in the hold mode.

When the conversion is completed, the binary value is transferred to the output circuit. There are two types of ADC output interfaces: parallel for interfacing with a PC's parallel port or similar connector; and serial for interfacing with the PC's serial port or other serial device. In the parallel mode, the data bits are simply loaded into latches and made available to the outside world.

When outputting serial data, the data bits are stored in an FIFO (first in, first out) register and clocked out at a rate that's compatible with the receiving device. Some ADCs let you choose between the two interface types, but most are fixed at one type or the other.

At the helm of all this activity is the control logic circuit. It's the job of the control logic to set the T/H gate in the hold position, input its value into the feedback comparator, strobe the SAR and DAC, lock the finished conversion into the output data buffers, and ready the ADC for another conversion. The clock, which may be internal or external to the chip, determines how long this sequence takes.

DAC Details

Critical to the performance of the successive-approximation register ADC is the DAC. Regardless of how fast you ripple through the SAR registers, it takes time for the feedback voltage from the DAC to settle down to a stable value — this is the ADC's single most speed-limiting factor, not the clock rate.

Basically, the DAC consists of a switching network woven around a voltage-dividing ladder array (Figure 4). Each switch represents a data bit; the position of the switch in the ladder determines the value of the bit. Switches that are closer to the top of the ladder have more weight, and therefore more value, than those farther down the ladder. To convert a binary number into an analog voltage, the switches connect the ladder tap to either the reference voltage or ground, depending on whether the binary value is a one or a zero.

While still a popular technology, 12-bit ADCs based on laser-trimmed, thin-film resistors have largely given way to ADCs based on switched-capacitor technology. Switched-capacitor ADCs employ the oxide capacitors and bilateral switches (Figure 5) commonly found in CMOS and BiCMOS mixed analog/digital devices. The technology uses less power, has shorter settling times, and is less expensive to fabricate.

Multistep to Faster Speeds

No matter how much effort you

put into fine-tuning the DAC, though, you're going to find yourself up against a rather imposing speed limit. Even with today's best technology, the best you can hope for in a SAR design is about 1 MHz. To break through this barrier, you have to step up to flash technology.

A flash converter performs a conversion within a single clock cycle, compared to the 14 or more clock cycles it takes for an SAR conversion. Analog-to-digital conversion is accomplished through a parallel array of voltage com-

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Deciphering ADC Specifications

Speed isn't the only performance concern. The DAC's DC specifications, notably linearity and drift, translate directly into conversion errors. One DAC trait, monotonicity, can create a particularly nasty error that causes some conversions to have missing codes. Here's a list of ADC performance parameters and what they mean.

Integral Nonlinearity (INL) is the maximum deviation from a straight line passing through the endpoints of the ADC transfer function, which are zero scale (a point 1/2 LSB below the first code transition) and full scale (a point 1/2 LSB above the last code transition).

Differential Nonlinearity (DNL) is the difference between the binary code of two adjacent conversions of the same value. The ideal value is 1 LSB or less with no missing codes over all temperature ranges.

Total Harmonic Distortion (THD) is the ratio of the rms sum of the output harmonic components to the rms value of the original input signal.

Peak Harmonic or Spurious Noise is the ratio of the output rms amplitude to the rms amplitude of the next largest spectral component of the original input signal. If the harmonic values are less than the noise floor, it is the largest peak.

Intermodulation Distortion (IMD) measures the mixed frequency processing characteristics of the ADC. If the input signal consists of more than one spec-

tral component, like f_1 and f_2 , nonlinearities in the signal path will generate intermodulation products. Like harmonic distortion, the products are grouped in stages of order, with (f_1-f_2) and (f_1+f_2) used to calculate the second order terms; $(2f_1-f_2)$, $(2f_1+f_2)$, (f_1-2f_2) , and (f_1+2f_2) for the third order terms; and $(3f_1-f_2)$, $(3f_1+f_2)$, (f_1-3f_2) , (f_1+3f_2) for the fourth order terms. The IMD calculation is usually done per the THD specification where the results are expressed as a ratio of input to output measured in dBs.

Signal-to-Noise Ratio (SNR) is the measured rms signal to rms noise at a specified input voltage and sampling frequency. The noise is the rms sum of all the spectral components, except the fundamental frequency and its first four or five harmonics.

Signal to Noise + Distortion Ratio (SINAD) is the rms signal to rms sum of all other spectral components below the Nyquist frequency at the output of the ADC. The theoretical SINAD ratio for an ideal N-bit converter with a sine wave input is: $SINAD = (6.02N + 1.76)$ dB. For a 12-bit converter, this value is 74 dB.

Full-Scale Error (FSE). The last code transition should occur 1-1/2 LSBs below positive full-scale value. Full-scale error is defined as the deviation of the actual code transition from this point.

Offset error. The last code transition should occur 1/2 LSB above the negative full-scale value. Offset error is defined as the deviation of the actual code transition from this point.

Full Power Input Bandwidth is the frequency at which the amplitude of the digital output work has decreased 3 dB below the amplitude of an input sine wave that has a peak-to-peak value equal to the reference voltage.

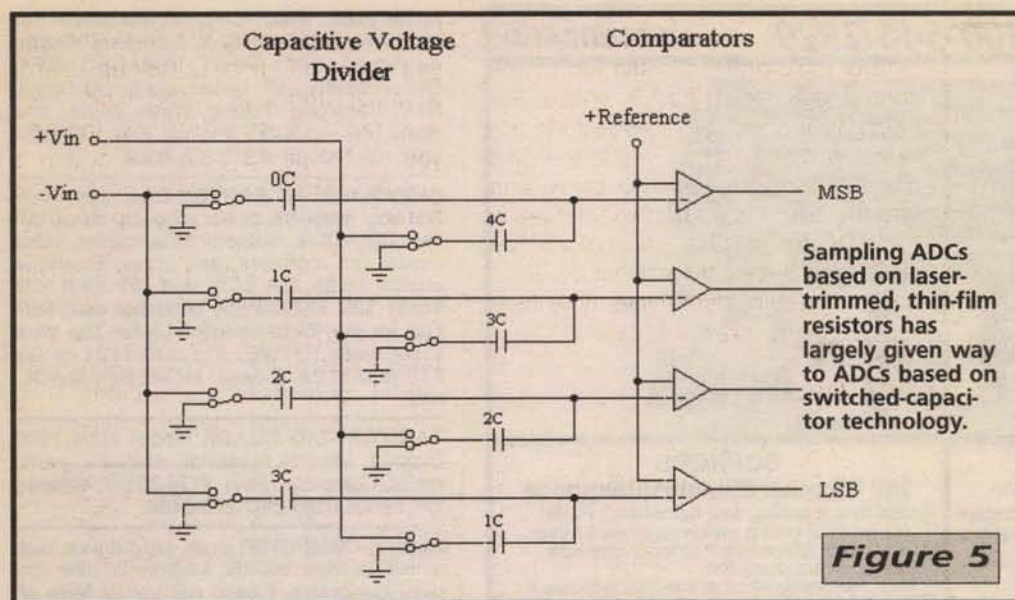


Figure 5

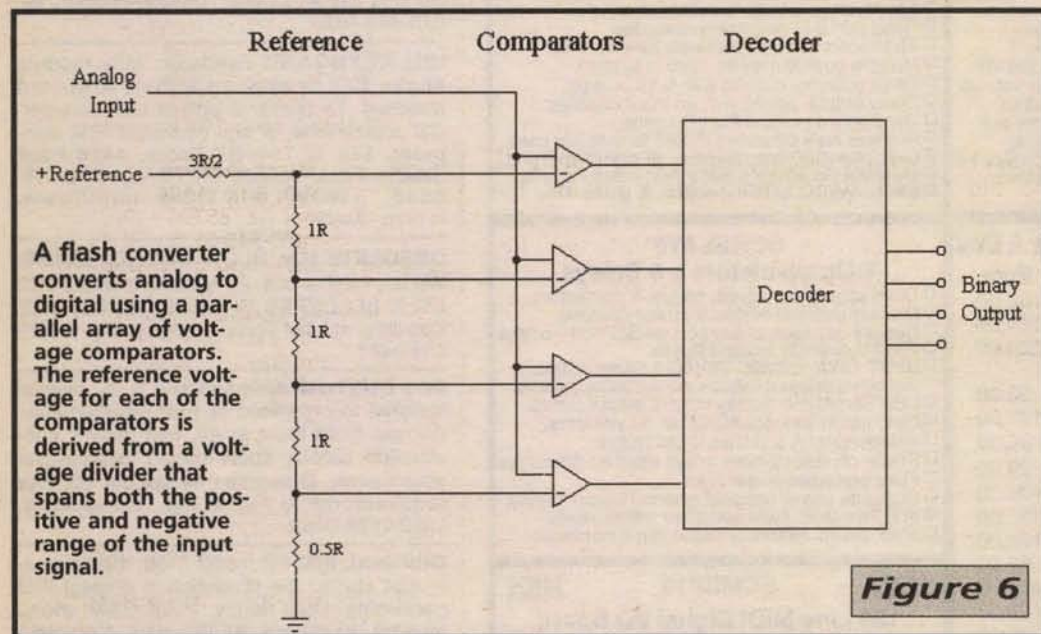


Figure 6

parators. In the block diagram of Figure 6, four comparators are used to achieve a two-bit resolution. The reference voltage for each of the comparators is derived from a uniformly-spaced voltage divider that spans both the positive and negative range of the input signal. The sampling inputs, on the other hand, are tied together and connected to the unknown input voltage.

As the input voltage increases, the comparators turn on in succession as the input voltage exceeds their threshold levels. At zero volts, none of the comparators have an output; at $V/4$, the first comparator turns on, at $V/2$ the bottom two generate an output, and so forth. These outputs are analyzed by a logic encoder circuit, which converts the concatenated signals into a binary equivalent. This value is latched into the decoder's registers on the falling edge of the clock.

The number of comparators increases geometrically as the number of bits increases. For example, an 8-bit flash converter requires 256 comparators, and a 10-bit flash converter needs 1024. By the time we hit 12-bits, the number has increased to a whopping 4096 comparators. Unfortunately, it's not practical to build a monolithic 12-bit flash converter simply because all the comparators have to be perfectly matched, otherwise you get missing bits, uncertainty errors, and jitters — just to mention a few problems. It's

tough enough to match a handful of ladder resistors, much less a thousand comparators. The practical limit is about 64 comparators, which translates into just 6 bits — far too small to be of any use ... or is it?

The problem can be solved using multistep architecture, where the analog-to-digital conversion takes place in two or more steps using cascaded flash converters — like the three-step converter shown in Figure 7. A typical conversion goes something like this:

The unknown input voltage is captured by a sample-and-hold amplifier (SHA) and routed to the first of three flash converters. A 4-bit approximation of the input is then made by the first flash converter, and the results passed along to a 4-bit DAC and a correction logic register, which sets the range for the following conversions. The approximation is then subtracted from the SHA's output to produce a remainder, or residue, equal to about one-eighth the original input voltage,

which is sent to the second flash converter.

The second flash has an input range that has one bit of overlap with the previous DAC. A second flash conversion is made, and the result is loaded into the correction logic register and the next DAC. Another subtraction is done to create an even smaller residue that's fed to the third and final stage — a 6-bit flash converter.

Again the input range of the flash converter overlaps the output of the preceding DAC by one bit to ensure data integrity. A final flash is done, and the results are added to the correction logic register. The 14 outputs from the three flash converters accumulated in the correction logic register are then added together using a correction algorithm to produce a 12-bit result.

Heard it Through the Pipeline

While multistep architecture can easily speed the ADC's performance past 1 MHz, the feedback DACs still impart a significant speed hit. If we take a page from the Pentium cookbook, though, it's easy enough to see how to improve on this design using a simple technique called pipelining. Pipeline architecture lets you process data assembly-line style, in

exactly the way a car is built on an assembly line. Although it takes hours to fully assemble a car, cars come off the assembly line at the rate of several per hour once the pipeline is started.

The only thing needed to modify a multistep ADC for pipelining is a sample-and-hold amplifier at the input of every stage. As before, the first SHA locks in the unknown signal, the first converter is flashed, and the results stored in the correction logic register. However, instead of holding this value in queue and tying up the first stage for the remainder of the conversion, a second SHA samples and captures its output, which makes the first stage available for new data. The first stage now acquires another sample, while, at the same time, the second stage processes the results of the first sam-

ple. The next clock tick advances the data down the pipeline, and acquires another new sample. In essence, the converter is converting multiple inputs simultaneously, processing them through the converter chain serially.

The result is an ADC with sampling rates up to 5 MHz at a cost that's only slightly more than a 1-MHz ADC. However, pipelined ADCs still have a latency factor, albeit not as long as the signal delay found in SAR converters, that could make it unsuitable for use in some real-time applications. Furthermore, pipelined ADCs experience a minimum sampling rate below which the charge in the SHA holding capacitors bleeds off and corrupts the data in the pipeline. Typically, the minimum sampling rate is 20 KHz.

Power Considerations

Unlike the ADCs of yesteryear, which required both a positive and a negative power supply, most ADCs can operate from a single-ended 5-volt power source; a few are 3-volt compliant. Current requirements, too, have taken a giant plunge downwards thanks to widespread use of CMOS technology. While power dissipation generally increases as the sampling rate increases, few exceed 300 milliwatts (mW) and it's not hard to find ADCs with power levels as low as 30 mW.

Many newer ADCs also provide power-saving features, like nap and sleep modes, that further reduce power. A good example of the amount of power you can save by using the power-saving modes can be found in Linear Technologies LTC1410, which dissipates 230 mW in the normal mode, 12 mW in the nap mode, and just 100 microwatts (uW) in the sleep mode.

Ready to Rumble

With all the features these 12-bit ADCs have to offer, it's little wonder they have taken the market by storm. Not only do the fast sampling rates make it possible to deal with high-frequency signals that heretofore were the sole domain of flash converters, low-power consumption, and low cost make them ideal for use in many digital designs.

In next month's installment, I'll show you how to use 12-bit ADCs in practical PC and battery-operated designs. **NV**

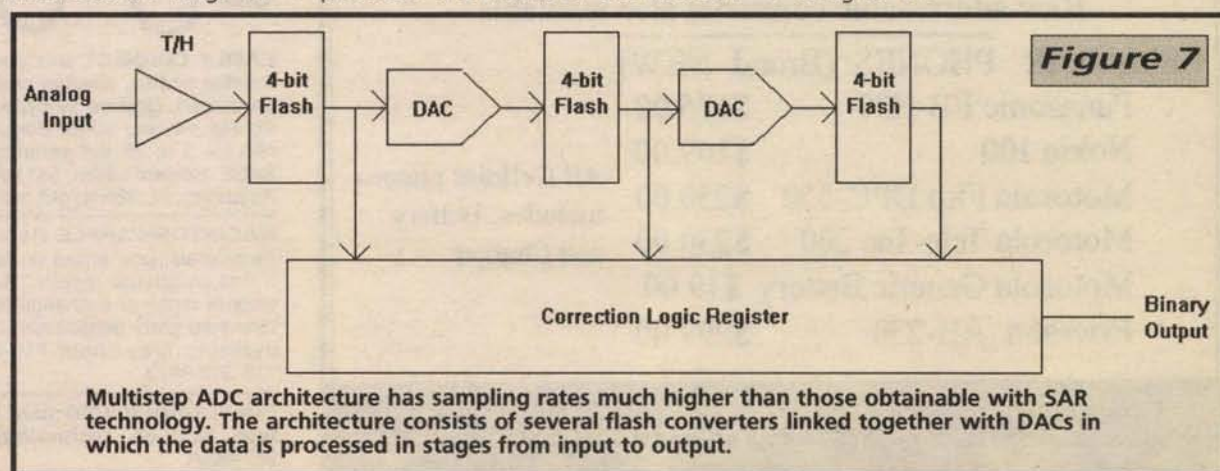
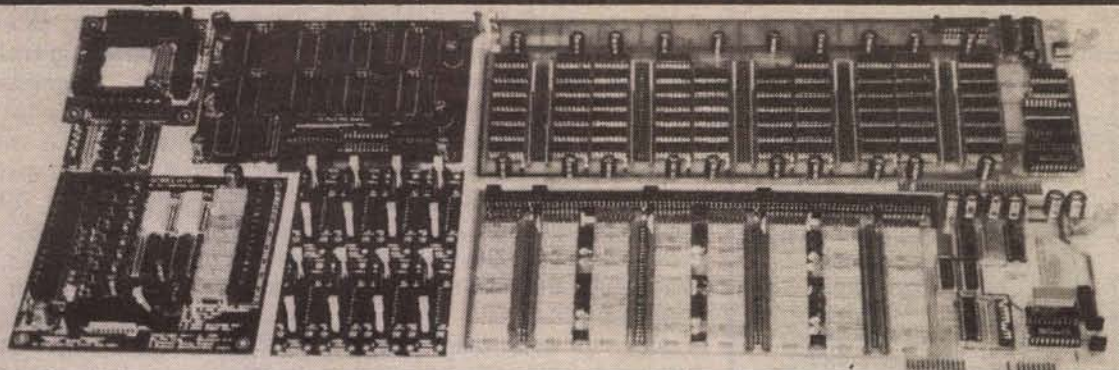


Figure 7



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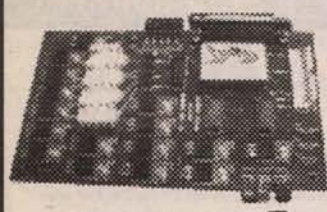
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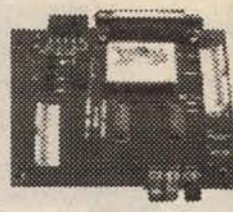
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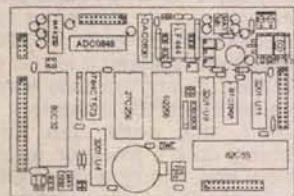
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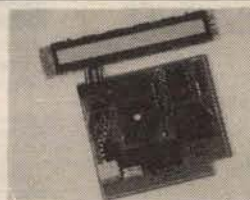


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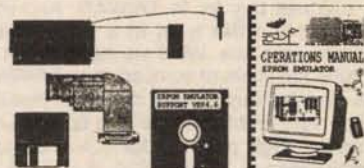
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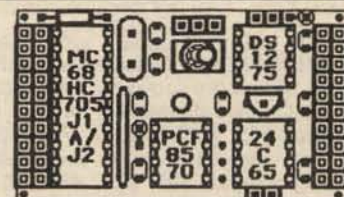
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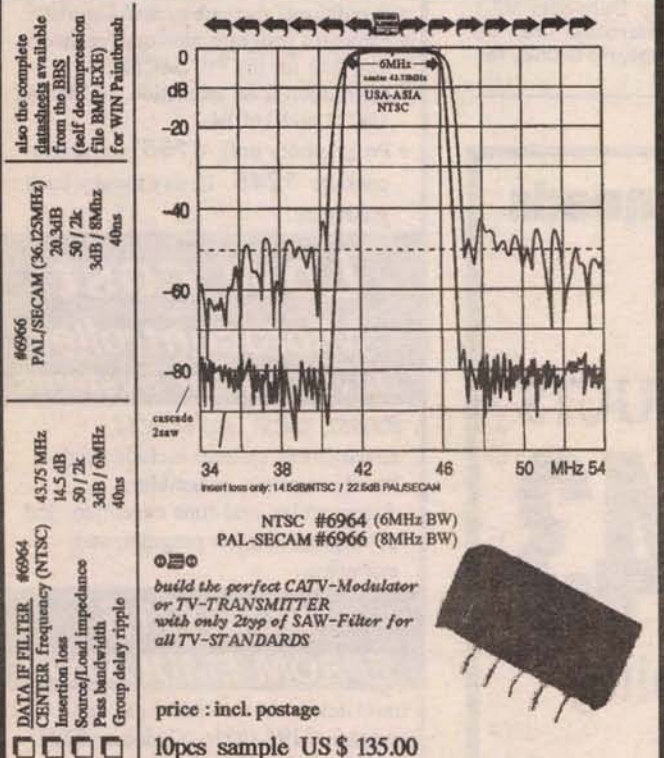
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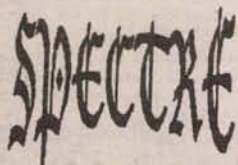
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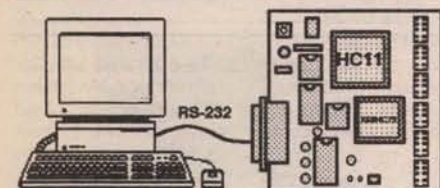
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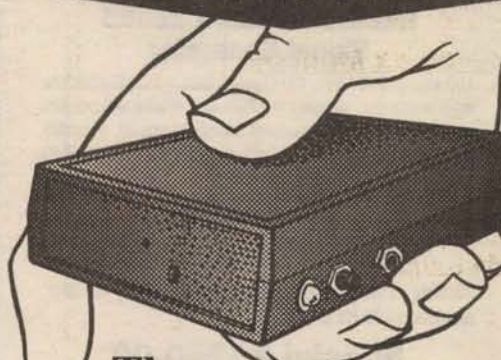
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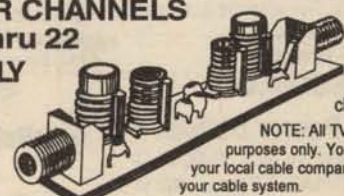


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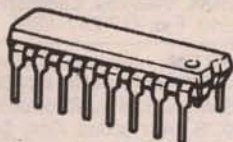
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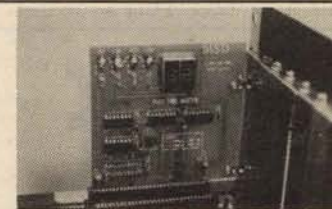
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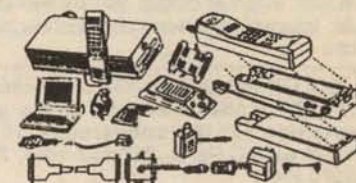
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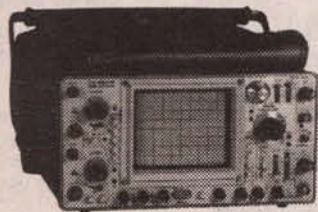


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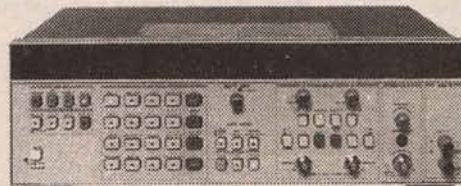
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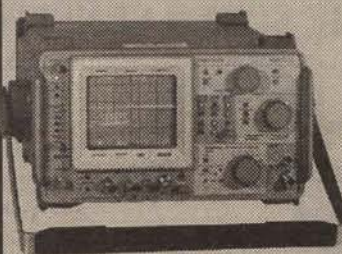
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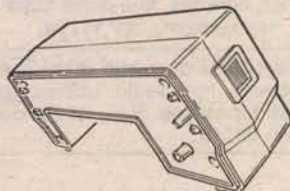
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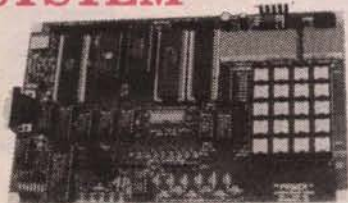
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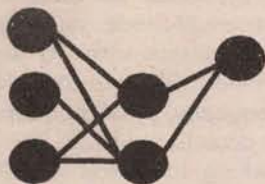
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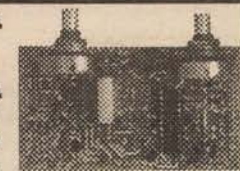
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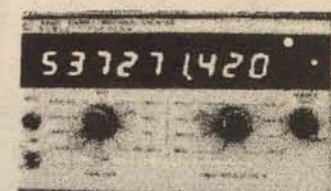
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The no-code Technician class license has dramatically increased the amount of weak-signal work on amateur radio VHF and UHF bands:

Six meters: 50.100 and up, upper

sideband
Two meters: 144.200 calling, upper sideband
70 cm: 432.100 calling, upper sideband

nas that FM operators will use for local repeater contacts. Weak-signal operators employ large VHF and UHF horizontal beam antennas to intensify transmit and receive capabilities when the band opens up.

Six-meters traditionally "opens up" during daylight hours from spo-

ly trigger a tropospheric duct where a warm air inversion will carry two-meter signals well beyond 1,000 miles.

On 432 MHz, skywave refraction is non-existent, but tropospheric ducting for hundreds and sometimes thousands of miles is common during August and September. Same for

and microwave spectrum. Our goal is to preserve weak signal work on the sub-bands as set forth in the ARRL band plan; and the education of the general amateur community in the interests of the weak signal operator," adds Peters. (Membership to the Western States Weak Signal Society

WEAK SIGNAL OMNI LOOPS

sideband

Two meters: 144.200 calling, upper sideband

70 cm: 432.100 calling, upper sideband

Many new no-code Technician class operators look for longer range

radic-E ionospheric refraction during the summer months, and a short peak around December. Single-hop and double-hop skywave communications on upper sideband can easily travel 2,000-3,000 miles away. Sometimes further.

On two meters, sporadic-E skip

1296 MHz and higher, too.

Every area of the country has weekly weak-signal nets on VHF and UHF frequencies. The net control station must constantly swing their highly directional beam antennas to focus in on local and distant station reception. Well, most net controllers. In Southern California, the Western States Weak Signal Society net control operator, David Peters KI6FF, runs the net from his home with four omnidirectional loop antennas stacked vertically in a collinear configuration for maximum compression of the horizontally polarized signal with communication capabilities out to 600 miles.

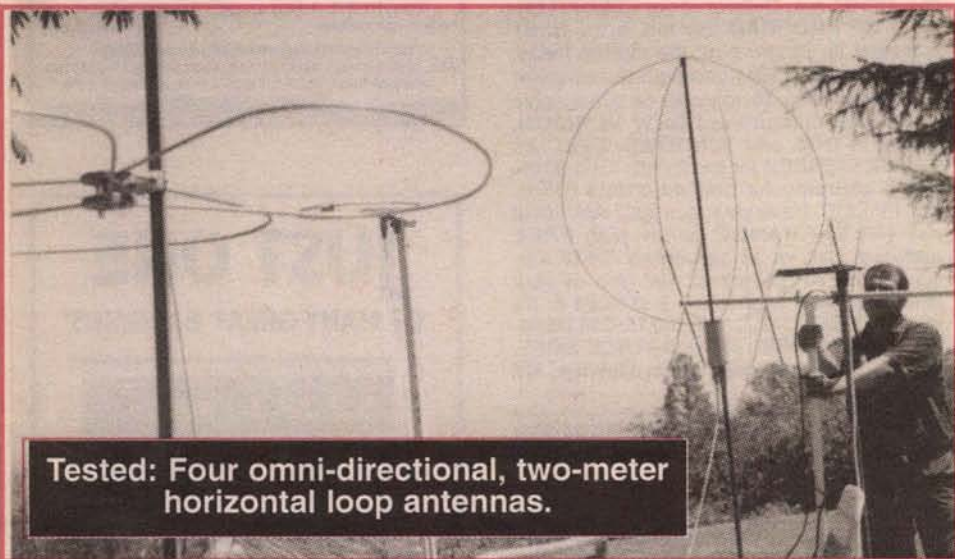
"I many times hear stations coming in from the Bay Area, and can successfully communicate with them when the tropo duct is in," comments David Peters, formerly Secretary/Treasurer for the Western States Weak Signal Society, and currently the #1 net control operator found on 144.240 MHz Sunday evenings at 8:00 p.m. in Southern

by Gordon West

is \$10.00 per year, which includes their informative newsletter, c/o of KI6FF, 14291 Middletown Lane, Westminster, CA 92683.)

Weak-signal activity has had a sharp increase on six meters and two meters thanks to Alinco incorporating six-meter, multi-mode SSB into their worldwide HF DX-70 transceiver. Ten watts out on six meters SSB, but 10 watts on six is plenty when fed into a horizontal antenna.

ICOM America with their new IC-706 incorporates six meters at 100 watts out multi-mode, single sideband plus two meters with 10 watts out multi-mode, SSB, into their 100-watt, high-frequency, multi-mode transceiver with detachable head. The IC-706, seen selling for below \$1,195.00 is fast becoming one of the most influential high-frequency transceivers around because of the included six-meter and two-meter bands all in one nice, neat package.



Tested: Four omni-directional, two-meter horizontal loop antennas.

and more excitement than what traditional FM repeater and FM simplex can offer on six meters, two meters, 440 MHz, and up. On the weak-signal portion of the bands, skywave skip communications may come in during the summer months giving weak-signal operators on single sideband tremendous excitement on six meters and occasionally on two meters. The FMers don't even know that the band is open! And when summertime tropospheric ducting occurs, 432 MHz weak-signal operators are talking simplex over distances of 1,000 miles, yet the FMers have no idea that the band is open.

NO FM ON THE BOTTOM OF THE BANDS! The VHF and UHF band plans specifically reserve the bottom of each band for CW and single sideband use only. (See Table 1.)

Weak-signal operators all use horizontal polarization for their long-range communications, as opposed to the more customary vertical anten-

occurs about 20 times a year in June and July. Typical two-meter upper sideband sporadic-E skip range is about 1,500 miles maximum.

Two-meter tropospheric ducting occurs in August and September. Sometimes tropospheric ducting can carry a two-meter signal for over 2,000 miles away over water. Weak-signal operators have communicated for days between Maine to Florida, Florida to Texas, California to Hawaii, and the Great Lakes down to the Panhandle. Static weather conditions, dominated by a stalled high-pressure system, will usual-

New Icom IC-706, with two-meter & six-meter weak signal capabilities including HF, too!



California. "Our Western States Weak Signal Society is like many other VHF/UHF weak-signal groups that extend the understanding of weak signal propagation activities and its technologies in the amateur VHF, UHF,

Kenwood Corporation offers single-band, multi-mode VHF and UHF transceivers, as well as a dual-band, multi-mode base station. Yaesu does, too, offering three bands of VHF and UHF capabilities in their 736R incorporating

six meters, two meters, and 432 MHz weak signal. Yaesu also has single-band SSB VHF and UHF transceivers, too. And ICOM, again, also has a dual-band, multi-mode base station.

But relatively new is the desire for weak-signal enthusiasts to take their operation mobile or rover or portable. Any type of mobile or mobile marine set-up requires an omnidirectional, horizontal antenna, and this is where the loop antenna has recently regained such popularity that now individual hams are home-brewing their loops for extremely low prices for sale to other hams who may wish to go on the air horizontal, omnidirectional mobile.

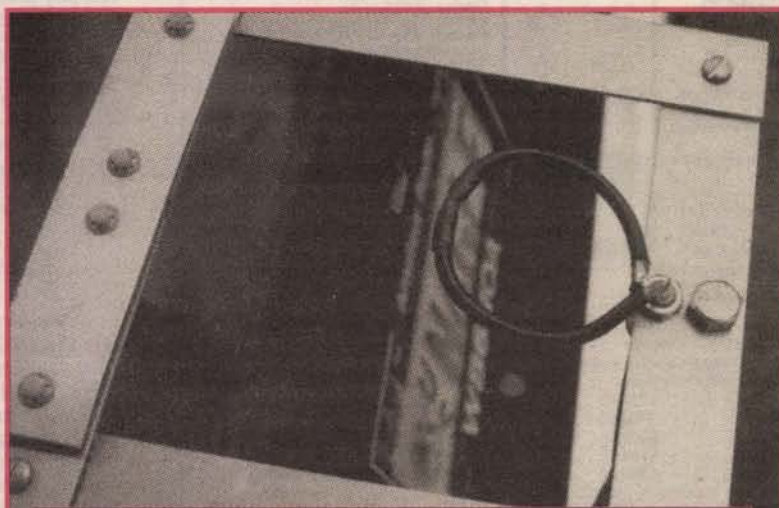
In repeated tests of various horizontal, single- and double-stacked loops, I have found that each loop has its own unique characteristics for pulling in weak signals. None of them were tested bad, and each of them were tested good in their own specific size and signal capturing characteristics.

The very smallest loop comes from ham operator and antenna designer, Norm Pedersen KB6KQ, of Bellflower, CA (310-925-0733). He calls his set-up the "Mini Loop," and it is the smallest loop that has absolutely terrific signal capture capabilities. Until you stack two of his loops together, you really don't achieve significant "gain" over a reference dipole which is bidirectional. However, the single or stacked Mini Loops were stellar performers when communications were conducted between a Mini Loop mobile in Southern California to Hawaii mobile-in-motion Mini Loop operated by Paul Lieb KH6HME, while Paul was driving up the side of the Mauna Loa volcano during a recent tropospheric duct.

"I couldn't believe my ears when I heard how well he was coming in on the loop I made for him," commented Pedersen, an enterprising ham who puts these together in his

garage with the precision of a high-tech antenna manufacturing facility. The two-meter "Mini Loop" is actually a loop matching section within an outer loop that has a capacitive matching network at the far end of the feedpoint. The Mini Loop measures 10-1/2 inches across and is so lightweight that you'll probably want to stack a pair with his exclusive matching harness device for a compressed horizontal radiation pattern. If you plan to go mobile, the Pedersen "Mini Loop" is my first choice.

Another popular horizontal loop is manufactured in his garage by Laddy Reisinger N8EWU, in Oceanside, CA (619-722-8563). These are the clover-leaf, fullwave radiators of which David Peters has four of them stacked vertically for best compressed horizontal radiation. For omnidirectional net operation, a stack of these loops measuring four feet across can really pull in the weak signals in all directions. The craftsmanship is superb, and if you really want an antenna that stands out on a mobile unit, you could put these aboard your car or motorhome and really stop some traffic! A little large for mobile use, but great for base station or fixed mobile operation, including mobile marine. I talked several hundred miles mobile marine with a single Laddy Loop.



Close-up of the M2 omni "Squoop" with plastic cover removed to see the inside construction and matching network.

50.0-50.10	CW only, NO FM
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145.80-146.00	Satellite CW & upper sideband, NO FM
222.00-222.15	CW & upper sideband, NO FM
432.00-433.00	Upper sideband & CW only, NO FM
1296.00-1296.30	Upper sideband & CW only, NO FM

Table 1

Probably the best-known commercially manufactured loop for single-band weak-signal operation is from Mike Staal K6MYC, of M Squared in Fresno, CA (209-432-8873). One is called the "Squoop" and is a high-cue, capacitively matched at the feedpoint, square loop sized about 10 inches as the round Mini Loop. The M Squared "Squoop" is encased with plastic to keep moisture from detuning the high-cue matching network.

The performance of the M Squared "Squoop" was judged close to the Mini Loop, but we found that the Pedersen Mini Loop many times would pull in extremely weak signals better than the Squoop when both were absolutely horizontal to the water or earth.

However, the Squoop many times would slightly edge out the Mini Loop when we were using it aboard a boat and our Squoop was not necessarily horizontal with the water. It was really tough to say exactly which one was best overall because each seemed to have their own preference for best distant station reception on separate tests on two meters and on 432 MHz.

Another popular omnidirectional mobile antenna from M Squared is the "Egg Beater." This can be used for both two-meter horizontal SSB communications, or a smaller version for 432 MHz communications. Not only is it horizon-

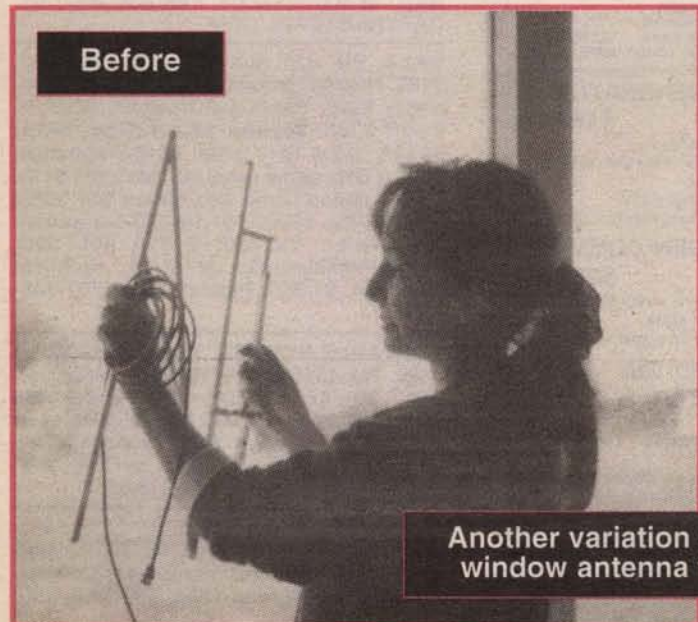
tally polarized, but also offers right-hand circular polarization to work and listen to orbiting satellites. You can also place the Egg Beater over a 1/4 wavelength separated piece of metal, and this will further enhance its upward circular pattern.

The Egg Beater is a commercially manufactured antenna system, and comes with all the neat mounting hardware and necessary attachments to bolt it to just about anything in the attic of your house, or to a mast for mobile use. Because of the size of the Egg Beater on two meters — over three feet tall with a very fat middle — this antenna is best operated mobile-marine or mobile-at-rest, as opposed to mobile-in-motion. We found that it whipped back and forth vigorously which chopped up the incoming weak signal from a distant station. But mobile-at-rest, it performed almost identically to the other three small horizontal loops.

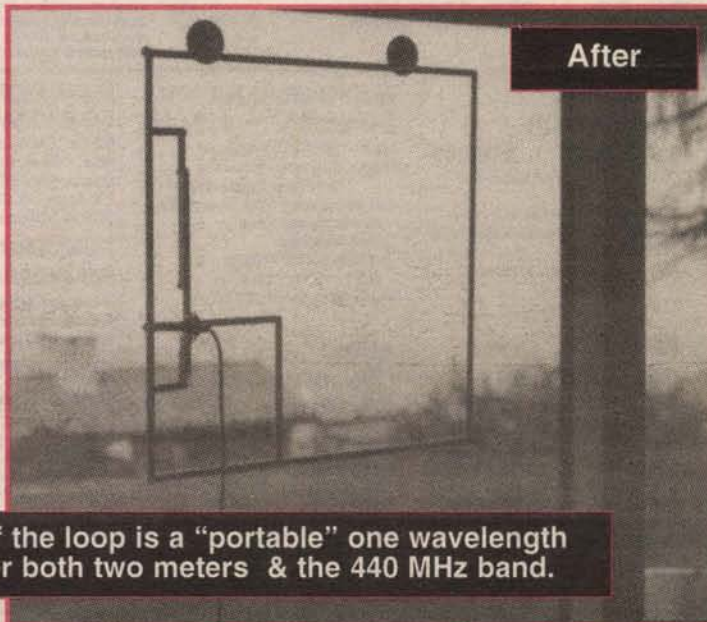
Would any of these loops perform as well as a small directional beam or quad antenna? We didn't think so, so we put them up against the Cubex four-element, pre-assembled "Yellow Jacket" quad, and the quad indeed pulled in signals better when it was pointed to the distant transmitting station (Cubex, Brea, CA; 714-577-9009). Under \$50.00, just like most of the small horizontal loops from Laddy and Pedersen. The commercial-rated M Squared loops run a little bit more, and this points out it's hard to beat the backroom construction techniques that weak-signal enthusiast hams like putting in on their home-brew projects.

Attempting to work SSB mobile from a vertical antenna will yield zip distant results. You must be horizontal, and driving a zillion miles an hour to get a whip to lay back flat is not the answer! The little loops ARE the answer, and you should call the manufacturers and try them yourself if you have a weak-signal SSB VHF/UHF transceiver and you want to get in on the long-range action that hardly anyone on FM knows about. The weak signals are horizontally polarized, and are just waiting for you to capture them with a horizontal omnidirectional mobile loop. **NV**

NOTE: There are over 30 weak-signal societies throughout the United States, and you should check with your local radio store to obtain the name, address, and phone number of the local society near you. Get involved — weak-signal operating this summer is going to be full of E-skip and tropospheric ducting.



Before



After

Another variation of the loop is a "portable" one wavelength window antenna for both two meters & the 440 MHz band.

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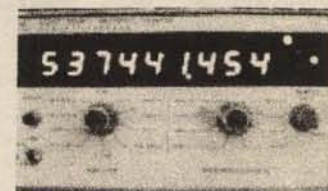
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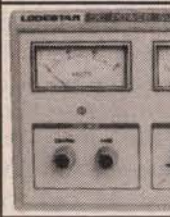


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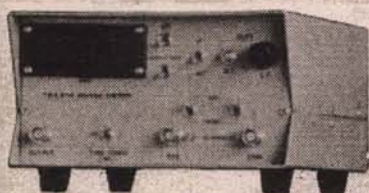
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JBI Products and Technologies introduces a computer-radio interface kit as a low-cost alternative to the amateur community for computer control of their radio equipment. The JBI Universal Radio Interface is compatible with Kenwood, Yaesu, Icom, Heathkit, and Ten-Tec transceivers which are designed for computer control.

The Radio Interface Kit can be easily constructed in about an hour; it is powered directly through the computer COM port, and fits completely within the metal die-cast serial port connector.

The kit comes complete with a PC board, all components, six-foot cable, DB-25 connector, radio port connector, and control software diskette. Also available is a CW keying option and completely wired and assembled kits.

The interface can be used with any personal computer that has an RS-232 compliant serial port, provided that compatible radio control software is loaded. Software for the IBM compatible PC is supplied with each JBI Radio Interface.

Use of the interface allows the radio amateur to change bands, frequency, mode of operation, and channel memory contents right from the computer keyboard. With the CW keying option, the computer keyboard can also be used to send Morse Code and directly key the transceiver.

Automatic logging of contacts is possible by using the interface to read QSO information such as band, frequency, mode of operation, and transmit time directly from the transceiver. Your favorite net or ragchew frequencies can be programmed into 99 available memories. Word descriptors can be assigned to the memory locations so that each frequency can be easily identified with its special use.

The most beneficial use of the interface is with contesting. With the appropriate contesting software and the interface, message generation,

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CELLULAR SURVEILLANCE SYSTEM 8000

Electronic Countermeasures, Inc. announces their new CSS-8000 cellular surveillance monitoring system.

The CSS-8000 is a professional computer controlled intelligence gathering tool for cellular systems. It is available with 1 to 24 receivers. Its leading-edge software design allows you to select the best hardware configuration for each operation and eliminate days and weeks of hit and miss surveillance.

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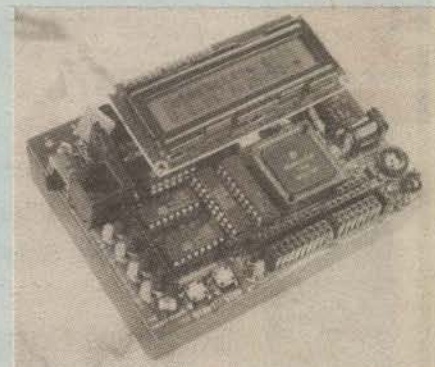
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For more information, contact one of the distributors, or see the Handy Board home page on the World Wide Web.

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Continued on page 115

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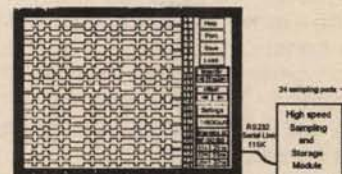
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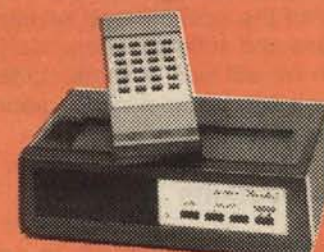
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Nuts & Volts Magazine/May 1996 29

RESOURCE BIN

number fifty two

Choosing your own personal computer

Our usual reminder here that the *Resource Bin* is now a two-way column. You can get tech help, consultant referrals, and off-the-wall networking on nearly any electronic, *tinaja* questing, personal publishing, money machine, or computer topic by calling me at (520) 428-4073 weekdays 8-5 Mountain Standard Time.

I'm now in the process of setting up my new *Guru's Lair* web site you will find at (where else?) www.tinaja.com — This is the place you go for instant tech answers. Among the many files in our library, you will find complete reprint sets for all of the *Resource Bin* columns. Along with some new "rich text" global search features.

The site is still under construction, but I fully intend to move thousands of my files here. So, definitely come visit. But bear with me for a while till things really get into gear.

You will get the best results if you have both *Netscape Gold* and *Acrobat Amber*. These are downloadable from www.netscape.com or www.adobe.com

Which Computer?

Uh, a slight change of plans. This month, I was going to talk about some of my favorite software. But it makes more sense for us to look into a few hardware fundamentals first.

So, instead, I thought I would take you "behind the scenes" and review the systems and software I personally use. Then we will look at some of the options you have in picking up your own personal computer.

My Own Systems

My number two system is an older Macintosh LC III. Its Ethernet set-up is crucial to all of my Book-on-demand publishing. The Mac also doubles for laser printer testing and development. I also use it for GENIE PSRT access and for system file translations.

Bee uses this Mac for bookkeeping, investments, correspondence, taxes, and such. Her favorite tools here are Quicken and Excel. With occasional use of Illustrator and PhotoShop.

MacInTax and *Word*, too.

Our number three system is a new multimedia Pentium. So far, this gets used primarily for Internet access, for webmastering my *tinaja.com* site, and for PIC development.

Number four is an older Apple IIgs. Used by Stacey and Chuck for catalog requests, for order entry, and mailing labels. And for my back-up BOD work. Bee uses this extensively for much of her graphic design, type-setting, and desktop publishing.

My "also rans" here include a fresh set of new PIC development systems that I am currently reviewing. Most notably that *Clearview* by *Parallax* and the *Rice16XX* by *TransData*. I am also purportedly doing development work on the cute new *Mensch I* computer from *Western Design Center*. And, if I need a lab microcomputer lashup in a hurry, my good old KIM-1 usually can come to the rescue.

By the way, I do have a few extra KIM-1s left and a unique collection of

NEXT TIME:
Don shows us a few of the Actors and Acrobats he personally uses.

classic collectible micro trainers up for sale. Even some *Micro Professors* with built-in printers! Write or call if you need more info on these.

Numero Uno

Exactly what is my first, finest, and foremost computer system? Thought you'd never ask.

Well, me being me, it is a superb *Hewlett Packard 4M+* general purpose PostScript computer. Controlled by AppleWriter and its WPL supervisory language on an Apple IIe. Well, really a IIgs run exclusively in its Apple IIe fast emulation mode.

I run well over 90 percent of my work on this system. The 68040 and its coprocessor, a hard drive, and 20 megs of RAM in the 4M+ make a jim dandy "mother's little helper" for the 65C02. Sort of a silicon *Au Pair* girl.

Oh, yeah. That great 4M+ general

purpose PostScript computer is also capable of dirtying up otherwise clean sheets of paper. In its spare time. But only when it isn't doing vastly more important stuff.

I do *all* of my writing, and *all* my technical illustrations on this system. Plus magic sinewaves, letter writing, consulting, my stock market tracking, printed circuits, and math analysis.

To this day, I still consistently do all of my highest productivity and all of my best creativity on this system. Gracefully and elegantly. In a totally virus-proof environment.

While I don't expect many others to follow this route, it certainly works very well for me. And I'm still utterly dumbfounded at the way many users *completely ignore* any use at all of *by far* the finest computer they own. Simply because some epsilon minus back at the factory put a stupid label on it. An obscenely misleading label that says "printer" instead of "general purpose PostScript computer."

I have just received a loaner of a new mind-boggling 5SIMX, so the old 4M+ may be in jeopardy. Just as soon as I cobble up a serial interface for the beast. While a tad pricey, the 5SIMX looks like a near-perfect machine for most higher volume Book-on-demand publishing. Duplex, hard drive, real Postscript, 11 x 17, 24 pages per minute, service manuals available, really great recharge economics.

And I do want to be the first one on my block to use a 5SIMX as a hot tub controller.

Whither Macintosh?

Well, wither actually. As in "on the vine" even.

I have long been a manic Apple enthusiast. My original Apple was serial #1243. And I am good friends with #42. I've written dozens of Apple books and zillions of Apple columns. I have been an Apple developer, a IIgs seeder, and I did their primary beta debug on LaserWriter 47.

Until recently, Apple consistently and obviously offered innovative tech excellence, elegant simplicity, and an incredible "plug-and-go" ease of use. They were pretty much the first with viable personal computers, the first with total graphic interfaces, and the first with desktop publishing.

It appears to me they blew it all. Utterly and completely. I have always said it would require extremely frigid conditions in a very unpleasant locale for me to ever buy or recommend a PC. I find those Wintel grunge and sleet factors to be abhorrent.

To this day, I still firmly do believe that *any* integrated circuit whose part number starts with an eight will end up intrinsically vile and despicable.

Well, hell froze over last month. I could no longer put off getting a PC. Mostly for net access, webmastering, and PIC development.

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Sorry, but I flat out could find no compelling reason to renew my Apple developer status this year. To me, it appears that developing for the Apple has clearly become a sucker bet.

Barring a second-coming miracle similar to the one those Amiga rabids have long been doing penance for.

In fact, the only obvious difference I see today between Mac and Amiga is this: The Amiga has a vastly more loyal following and still clearly has a few innovative advantages. At least in video. Mac does not.

While it pains me grievously, I can no longer honestly recommend a Mac to anyone who does not already have one. It seems to me that continuing to teach Mac as the primary machine in a PC-dominant world can be a severe disservice to most students. One that borders on a criminal act.

Picking a System

So much has come down recently that buying a personal computer is a whole new ball game. Past your point where any older system is often *largely worthless*. No matter what the pricing, you should *avoid any and all previous systems*. Especially bargain ones out of your local paper or a ham-fest.

Unless you have plenty of expertise and some compelling vested interest in continuing with an old machine.

Thus, any MS-DOS system today is almost (but not quite) as useful as a CP/M machine.

You positively, emphatically, and absolutely should *not* even *think* of an older system if you are in any way new to computerdom.

The first and foremost key question to ask is "Can the beast do a graphic Internet access?" *Nothing else matters!* Anything less than this will do dated things old ways. Costing you far more time and money than any miniscule front end savings.

Minimum System Specs

The choices rapidly boil on down to two: a fast-fading Mac System 7 or higher or PC Windows, with Win 95 gaining the upper hand.

Let us define a workable baseline entry-level system. One that should meet most people's needs most of the time. And soon should be available in

the \$1,200.00 range. Printer extra.

Any mass market Pentium running Windows 95. Speed is not that big a deal for ordinary users, with 75 MHz adequate. Faster stuff costs more than it will benefit you. Besides, you can always cheaply upgrade later.

A CD-ROM for sure. Because most software these days is far too complex to load off floppies. There are several different CD-ROM speeds available. Namely: *really slow* (8X), *excruciatingly slow* (6X), *utterly appalling* (4X), and *glacial* (2X).

Note that the "times" figures refer to how fast the drive spins. The actual throughput of an 8X drive is nowhere near four times that of a 2X drive.

A bare minimum of 8 megs or RAM. Preferably 16. A built-in modem, 14.4 or higher. Fax if available.

A monitor with a *maximum* pitch of 0.28 millimeters. *Lower is better*. And a min display resolution of 800 pixels wide by 600 pixels high.

Everybody always lies about their monitor size. Screens are *far* smaller than you'd first guess. Note that a "15 inch" monitor has a display that's less than *eight inches* high!

Thus, to find your display height, you *divide your monitor size by two*. Try several different monitor sizes to see which is most cost-effective.

Some sound card or built-in sound capability. Preferably with speakers.

A built-in hard disk. Size: 800 megs minimum. Chances are you will fill up one of these in your first week of use. Especially since PC software is so obscenely bloated. If you are going to run video work or nonlinear editing, you might be able to squeak by with a 15 gig hard drive instead.

A printer? PostScript, of course. Do not even *think* of getting a printer that does not speak *real* Adobe PostScript. The best mid-range choice is by far the *Hewlett Packard 4M+*. But you can expect an improved 5M+ shortly.

If you need low-cost color, there's slower, low end inkjets that more or less work. The *Hewlett-Packard 650C* is one example.

One way to make low end printers handle PostScript is by use of Adobe's incredible *Acrobat*. Freebie viewers are found at <http://www.adobe.com> — Other possible options here include the use of

GhostScript or *Transverter Pro*.

The Wal-Mart Special

I found my own Pentium as a blue light special at Wal-Mart. \$1,390.00. Cash and carry with a six month warranty.

It is reasonable to expect a further price drop this year. Maybe \$999.00 for a comparable machine.

With monitor, but less printer.

It does pay to wait for sales. And to buy under the leading edge. Beware of anything that's two generations out of date. For instance, don't ever pay a penny over \$199.00 for a 486.

Everybody dumps on *Packard-Bell*. But hey — they're cheap. Uh, they're also cheap. My own problems have included a monitor that is unstable in higher res modes, its insistence of installing a nonexistent com channel on startup, and Ethernet hassles.

I've twice had to use their fee based tech support. Both times, I found it prompt, courteous, and cost-effective. Not to mention solving the problem at hand. Quickly and totally.

The other useful computer sources advertise in *Comp-U-Mart*, *Computer Reseller*, and *Computer Hot Line*.

By the way, you can completely forget about all of that \$500.00 Internet machine hype. The \$500.00 is just a secret insider code word for "let's all flush MicroSoft." And is brought to you by the same fascist thinking that brought you Big Brother mainframes, one-way Teletext, and diskless workstations.

As several very prominent industry leaders have proven to us beyond any shadow of a doubt, products do not sell all that well when their primary design motivation is simple spite.

Build Your Own?

Can you save by building your own computer up out of bits and pieces?

No way! Building your own car makes a lot more sense. Or your own microwave oven. Or even a German Shepherd.

The profit margin on typical mass-marketed computer systems will get measured in dimes, not dollars. You will be unable to find all the parts for anywhere remotely near the cost of a ready-to-use system. Especially when

you factor in such things as shipping and the value of your time.

One little problem with one bit or piece, and you will get into endless frustration. Uh, reliability counts. Big time. Besides, over 95 percent of any computer these days is your software and the operating system.

There is also no homebrew system warranty and you'll find a near total lack of technical support.

Building your own computer may make sense as a learning experience. Especially when you want to get into computer repairs and servicing. If so, *Heathkit* is often your best route.

But no way will any home building save you time and money.

If you absolutely insist on building your own system from the ground up, those previously mentioned *Computer Reseller*, *Comp-U-Mart*, and *Computer Hot Line* mags are useful sources.

Should you really want to continue on an older orphan system, there is a great *Computer Journal* magazine that tightly focuses upon these classics. Do not confuse this with a *Microcomputer Journal*, once called *Computer Craft*.

By the way, *Microcomputer Journal* does have a new publisher. Meaning it has a fresh chance of success.

This Month's Contest

For our contest this month, just tell me about your very favorite hardware set-up. Especially if it is unusual or oddball. Or off-the-wall.

There will be a largish pile of my new *Incredible Secret Money Machine II* books going to the dozen or so better entries, plus an all-expense-paid (FOB Thatcher, AZ) *tinaja* quest for two that will go to the very best of all.

Send all your written entries to me here at *Synergetics*, rather than to *Nuts & Volts* editorial.









Let's hear from you. **NV**

Microcomputer pioneer and guru Don Lancaster is the author of 33 books and countless tech articles. Don maintains his no-charge US tech helpline found at (520) 428-4073, besides offering all of his own books, reprints, and consulting services. Don also has two free catalogs full of his resource secrets waiting for you. Your best calling times are 8-5 on weekdays, Mountain Standard Time.

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





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



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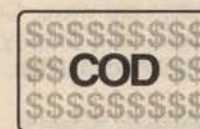
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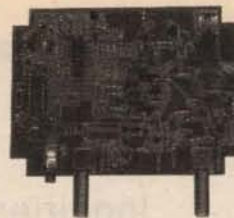


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- Sleep Timer
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- Favorite Channel Memory
- Parental Lockout
- STD/HRC Switchable
- Infrared Remote Control



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TEK 7104 1 GHz Oscilloscope, with 7A29, 7A29-04, 7B10, 7B15	\$5,000.00
TEK 7854 400 MHz Waveform Processing Oscilloscope frame	\$1,250.00
TEK 7904 500 MHz 4-slot frame	\$500.00
TEK 7904 500 MHz System, with 7A24, 7A26, 7B92A	\$1,000.00
TEK 7904 500 MHz System, with 7A24, 7A26, 7B80, 7B85	\$1,000.00
TEK 7A19 600 MHz Single Channel Amplifier	\$175.00
TEK 7A24 400 MHz Dual Trace Amplifier	\$350.00
TEK 7A26 200 MHz Dual Trace Amplifier	\$175.00
TEK 7A29 1 GHz Single Channel Amplifier	\$550.00
TEK 7B15 1 GHz Delaying Time Base	\$450.00
TEK 7B80 400 MHz Delaying Time Base	\$175.00
TEK 7B85 400 MHz Delta Delaying Time Base	\$200.00

STORAGE

TEK 7834 400 MHz Storage Oscilloscope, w/7A24, 7A26, 7B80, 7B85	\$1,250.00
TEK SC503 10 MHz Dual Trace Storage Oscilloscope, TM500 series	\$700.00

SAMPLING

TEK TS11 Sampling Unit	\$300.00
TEK TT11 Sampling Sweep Unit	\$750.00
TEK R7903/7S11/7T11/S-4 12 GHz Sampling Oscilloscope System	\$1,750.00
TEK S-4 14 GHz Sampling Head	\$300.00

PROBES

TEK 1101 Accessory Power Supply, for FET probes	\$250.00
TEK P6045 230 MHz 1X/10X/100X FET Probe	\$225.00
TEK P6046 100 MHz Differential Probe	\$750.00
TEK P6201 900 MHz 1X/10X/100X FET Probe	\$500.00
TEK P6203 10X 1 GHz Active Probe, for 11000 series	\$450.00
TEK P6205 750 MHz 10X FET Probe, for TDS/DSA/CSA/11000 series	\$275.00
TEK P6701-opt.01 O/E Converter, 450-1050 nm/0-1 mW; DC-700 MHz, FC conn.	\$675.00

CALIBRATION

TEK 067-0587-01 Signal Standardizer Calibration Plug-in, 7000 series	\$300.00
TEK CG551AP/TM506A Oscilloscope Calibrator, with pulse head & power module	\$3,500.00
TEK PG506 Calibration Generator	\$1,000.00
TEK SG503 Levelled Sine Wave Generator, 0.25-250 MHz	\$800.00
TEK SG504 Levelled Sine Wave Generator, 245-1050 MHz	\$2,200.00
TEK TG501 Time Mark Generator	\$750.00

WAVEFORM GENERATORS

FUNCTION

HP 3310A 5 MHz Function Generator	\$325.00
HP 3310B 5 MHz Function Generator, monocyde & var. phase trigger	\$425.00
HP 3312A 13 MHz Function Generator, sweep, AM, FM	\$850.00
HP 8015A 50 MHz Dual Output Pulse Generator	\$650.00
KROHN-HITE 2000 30 MHz Function Generator	\$675.00
TEK DD501 Digital Delay & Burst Gen., for function & pulse gen's	\$375.00
TEK FG502 11 MHz Function Generator, TM500 series	\$325.00
TEK FG504 40 MHz Function Generator, TM500 series	\$875.00
TEK RG501 Ramp Generator, TM500 series	\$225.00
WAVETEK 148A 20 MHz Function Generator, AM/FM/PM modulation	\$600.00

WAVETEK 166 50 MHz Pulse/Function Generator	\$1,250.00
WAVETEK 188 4 MHz Sweep/Function Generator, 20Vp-p	\$275.00

PULSE

HP 214B 10 MHz Pulse Generator, 50V/50 Ohms, auto duty cycle	\$1,650.00
HP 8005B 20 MHz Dual Output Pulse Generator	\$450.00
HP 8013B 50 MHz Dual Output Pulse Generator, 3.5 nS fixed Tr	\$600.00
HP 8015A-002 50 MHz Dual Output Pulse Generator, burst mode option	\$750.00
HP 8080A/81A/82A/83A 300 MHz Word Generator	\$600.00
HP 8080A/91A/92A/93A 1 GHz Single Channel Pulse Generator	\$950.00
HP 8080A/91A/93A 1 GHz Clock Generator	\$600.00
HP 8082A 250 MHz Dual Output Pulse Generator	\$1,400.00
PHILIPS PM5785B 125 MHz Dual Output Pulse Gen., burst mode, 1 nS Tr	\$875.00
TEK PG501 50 MHz Pulse Generator, TM500 series	\$250.00
TEK PG502 250 MHz Pulse Generator, Tr<1nS, TM500 series	\$700.00
WAVETEK 801 50 MHz Pulse Generator	\$450.00

PROGRAMMABLE

HP 3325A Synthesizer / Function Generator, 1 uHz-21 MHz	\$2,250.00
HP 3325A-002 Synth./Function Gen., 1 uHz-21 MHz, 40V out 1 uHz-1 MHz	\$2,400.00

HP 8160A 50 MHz Programmable Pulse Generator, HPIB	\$2,500.00
HP 8165A Programmable Signal Source, 1 mHz-50 MHz	\$2,600.00
TEK AWG5102 Arb.Waveform Gen., 20 MS/s, 12 bits, 50ppm synthesis <1MHz	\$1,400.00
TEK AWG5105 Arbitrary Waveform Generator, 50 MS/s, 12 bits	\$1,700.00
TEK AWG5105-opt.02 Arbitrary Waveform Generator, dual channel option	\$2,200.00
TEK PFG5505 Programmable 12 MHz Pulse/Function Generator	\$900.00

VOLTAGE & CURRENT

VOLTMETERS

HP 3456A 6-1/2 Digit Voltmeter	\$850.00
KEITHLEY 181 6-1/2 digit Nanovoltmeter, 10 nV sensitivity, GPIB	\$1,500.00
SOLARTRON 7081 8-1/2 digit Precision Voltmeter	\$3,900.00
SOLARTRON 7150 5-1/2 digit Multimeter, GPIB	\$450.00

CALIBRATION

FLUKE 332B/AF DC Voltage Calibrator, 0-1111 V, 0-50 mA, 7 decades	\$675.00
FLUKE 343A DC Voltage Calibrator, 0-1100V, 7 decades, 20 ppm acc.	\$1,375.00
FLUKE 515A Portable Calibrator, DC/AC/Ohms, line & battery power	\$1,700.00
FLUKE 5220A Transconductance Amplifier, DC-5 kHz, 0-20 A	\$3,750.00
FLUKE 720A Kelvin-Variety Voltage Divider, 7 decade	\$2,250.00
FLUKE 731B DC Reference Standard	\$400.00
HP 11049A AC Thermal Converter, 3V, 20 Hz-100 MHz	\$175.00
VALHALLA 2703 AC Volt Std., 0-120V/10 Hz-100 kHz; 120-1200V/10 Hz-1 kHz	\$2,500.00

VOLTAGE SOURCES

HP 6114A Precision Dual Range Power Supply, 20V 2 A / 40V 1 A	\$875.00
HP 6115A Precision Dual Range Power Supply, 50V 0.8A / 100V 0.4A	\$875.00

CURRENT METERS & SOURCES

DRANETZ 656A (3)TR2019A Current Demand Analyzer, w/(3) current probes 300A max.	\$5,000.00
FLUKE Y5020 Current Shunt, to 20 A, 0.01 ohm, DC-5 kHz	\$400.00
HP 6177C DC Current Source, to 50V, 500mA	\$600.00
HP 6181C DC Current Source, to 100V, 250 mA	\$675.00
HP 6186C DC Current Source, to 300V, 100mA	\$750.00
KEITHLEY 414A Picoammeter, 0.1 nA-10 mA	\$325.00
KEITHLEY 617 Programmable Electrometer	\$2,750.00
KEITHLEY 642 Electrometer	\$2,900.00
LEEDS & NORTHRUP 4360 Precision Current Shunts, 15-500 Amp	\$650.00
TEK AM503/P6302/TM501 AC/DC Current Probe package, 1 mA-5 A/div, DC-50 MHz	\$1,000.00
TEK CT-5-opt.05 High Current Transformer for P6021/A6302, to 1000A	\$500.00
VALHALLA 2301 Programmable Single Phase Power Analyzer	\$1,250.00
VALHALLA 2575A AC/DC Active Current Shunt, 20 mA-100 A, DC-10 kHz	\$1,000.00

IMPEDANCE & COMPONENT TEST

L.C.R.

BOONTON 62AD 1 MHz Inductance Meter, 2-2000 uH	\$550.00
E.S.I. 296V 4-1/2 Digit LCR Bridge, 120 Hz & 1 kHz	\$700.00
HP 4261A 3-1/2 digit LCR Meter, 120 Hz/1 kHz	\$1,000.00

STANDARDS

E.S.I. RS-925 9-Decade Resistor, 0.01 ohm-1.2 Megohm	\$1,600.00
E.S.I. SR1010 Resistance Transfer Standards, 1 ohm-100 K/step	\$700.00
FLUKE 5450A Programmable Resistance Standard, 2 & 4 wire	\$1,750.00
GR 1403-SERIES Standard Air Capacitors, 0.1% accuracy	\$150.00
GR 1409-SERIES Standard Mica Capacitors, 0.05% accuracy	\$150.00
GR 1432-N 5-Decade Resistor, to 11,111 ohms, 0.1 ohm res.	\$175.00
GR 1432-U 4-Decade Resistor, 0-111.1 ohms, 0.01 ohm resolution	\$125.00
GR 1433-U 4-Decade Resistor, 0-111.1 ohms, 0.01 ohm resolution	\$475.00
GR 1433-X 6-Decade Resistor, to 111,111.0 ohms, 0.1 ohm res.	\$550.00
GR 1434-G 7-Decade Resistor, 0-1,111,111.0 ohms, 0.1 ohm res.	\$400.00
HP 16380A Standard Air Capacitor Set; 1, 10, 100, 1000 pF	\$1,675.00
VALHALLA 2724A Programmable Resistance Standard, 0-11 Gigaohms, GPIB	\$1,675.00

HI & LO RESISTANCE

GR 1666 DC Resistance Bridge, 1 micro-ohm - 100 kilohms	\$750.00
HP 4329A High Resistance Meter, 5E5-2E16 Ohms, 10-1000 V test	\$1,350.00
VALHALLA 4150-ATC 4-1/2 digit Ohmmeter, 20 milliohms-2 kilohms, 4-wire	\$1,000.00

CURVE TRACERS

TEK 576 Curve Tracer, with standard test fixture	\$2,350.00
TEK 577D 1177 Storage Curve Tracer, with standard test fixture	\$2,250.00
TEK 7CT1N Curve Tracer, to 0.5W, 7000 series	\$400.00

T.D.R.

TEK 1503-opt.04 Time Domain Reflectometer, 0-50,000 feet, chart recorder	\$2,000.00
TEK 7S12/S-6/S-52/7854 T.D.R., 0-375 feet, 45 pS Tr, w/digital storage display	\$2,750.00

POWER SUPPLIES

SINGLE OUTPUT

HP 6031A Autoranging Supply, to 20V / 120 A / 1000W max., HPIB	\$2,000.00
HP 6201B 20V at 1.5A CV/CC Power Supply	\$200.00
HP 6206B Dual Range 0-60V 0.5 A / 0-30V 1 A CV/CL Supply	\$250.00
HP 6207B 160V at 200 mA CV/CC Power Supply	\$300.00
HP 6209B 320V at 100 mA CV/CC Power Supply	\$300.00
HP 6260B-027 10V at 100A CV/CC Power Supply	\$675.00
HP 6261B-027 20V at 50 A CV/CC Power Supply	\$675.00
HP 6263B 20V at 10 A CV/CC Power Supply	\$400.00
HP 6266B 40V at 5 A CV/CC Power Supply	\$400.00
HP 6267B 40V at 10 A CV/CC Power Supply	\$550.00
HP 6268B-027 40V at 30 A CV/CC Power Supply	\$850.00
HP 6299A 100V at 750 mA CV/CC Power Supply	\$250.00
HP 6384A 4.0-5.5V at 8 A CV/CL Power Supply	\$175.00
HP 6448B 600V at 1.5 A CV/CC Power Supply	\$850.00
KEITHLEY 240A HV Power Supply, 0-1200V, 0-10 mA, CV/CL	\$250.00
SORENSEN DCR 110-45T 110V at 45 A CV/CC Power Supply	\$2,200.00
SORENSEN DCR 300-8A 300V at 8 A CV/CC Power Supply, 208/230VAC line	\$950.00
SORENSEN DCR 40-40B 40V at 40 A CV/CC Power Supply, 120VAC line	\$950.00
SORENSEN SRL 60-8 60V at 8 A CV/CC Power Supply, low noise	\$950.00
TEK PS501-1 Power Supply, 0-20V, 2 mV res., 400 mA, TM500 series	\$175.00

MULTIPLE OUTPUT

HP 6227B Dual 25V at 2 A CV/CC Power Supply, tracking	\$550.00
HP 6253A Dual Output 20V 3 A CV/CC Power Supply	\$500.00
HP 6255A Dual Output 40V 1.5 A CV/CC Power Supply	\$500.00
TEK PS5010 Programmable Triple Power Supply, TM5000 series	\$800.00

MISCELLANEOUS

HP 59501A HPIB Isolated DAC/Power Supply Programmer	\$175.00
HP 6824A Bipolar Power Supply/Amplifier, to 50V, 1 A	\$400.00
HP 6827A Bipolar Power Supply/Amplifier, to 100V, 500 mA	\$800.00
KEPCO BOP-100-4M 100V, 4 A Four Quadrant Bipolar Supply / Amplifier	\$1,000.00
KEPCO BOP-36-5M Bipolar Op Amp/Power Supply, to 36V, 5 A	\$550.00

TIME & FREQUENCY

UNIVERSAL COUNTERS

HP 5314A 100 MHz/100 nS Universal Counter	\$225.00
HP 5315A-001 100 MHz/100 nS Universal Counter, TCXO reference	\$650.00
HP 5316A-003 100 MHz/100 nS Universal Counter, HPIB, 1.0 GHz C-chan.	\$1,000.00
HP 5335A 200 MHz Universal / Statistical Counter	\$1,500.00
HP E1420A-010, 030VXI card 200 MHz/ 2 nS Univ. Counter, TCXO & 2.5 GHz C-ch	\$900.00
PHILIPS PM665A/056 120 MHz/ 2 nS Programmable High Res. Counter, OCXO, GPIB	\$850.00
TEK 7D15 225 MHz Universal Counter/Timer, 7000 series	\$275.00
TEK DC5004 Programmable 100 MHz/100nS Counter/Timer, TM5000 series	\$350.00
TEK DC5009 Programmable 135 MHz Univ. Counter/Timer, TM5000 series	\$600.00
TEK DC5010 350 MHz/3.125 nS Univ. Counter, TM5000 series	\$1,000.00
TEK DC503A 125 MHz Universal Counter/Timer, TM500 series	\$450.00
TEK DC509 135 MHz High Resolution Universal Counter/Timer, TM500	\$550.00

FREQUENCY COUNTERS

EIP 578-opt.02.06 26.5 GHz Source Locking Counter, power meter & MMW opt's	\$7,500.00
FLUKE 7220A-opt.111 1.3 GHz Communications Counter, TCXO option	\$650.00
HP 5305B/5300B-001 1.3 GHz Counter Package w/TCXO ref., high res. audio	\$450.00
HP 5340A-001,011 18 GHz Frequency Counter, OCXO reference, HPIB	\$1,900.00
HP 5340A-005,011 23 GHz Frequency Counter, HPIB	\$2,000.00
HP 5342A 18 GHz Frequency Counter	\$2,350.00
HP 5342A-001,002,011 18 GHz Frequency Counter, OCXO, Power Measurement, HPIB	\$3,700.00
HP 5342A-001,011 18 GHz Frequency Counter, OCXO, HPIB	\$2,750.00
HP 5342A-003,011 18 GHz Freq. Counter, +22 dBm, -20 dBm dynamic range, HPIB	\$2,750.00
HP 5342A-01,04,05,11 24 GHz Frequency Counter, OCXO, DAC, and HPIB	\$3,900.00
HP 5345A/5355A/5356A-06 Pulse/CW Frequency Counter, 0.4-18.0 GHz, HPIB	\$3,500.00
HP 5382A 225 MHz Frequency Counter	\$200.00
SYSTRON-DONNER 6054B 24 GHz Frequency Counter	\$1,875.00
TEK 7D14 525 MHz Frequency Counter, 7000 series	\$175.00

STANDARDS

EFRATOM FRK Rubidium Frequency Standard Cell, 10 MHz, 24VDC	\$675.00
HP 105A Quartz Oscillator, 0.1 / 1.0 / 5.0 MHz	\$750.00
HP 5087A-031 Distribution Amp., 0.1/1.0/5.0 MHz x 4 channels each	\$1,250.00
HP 5359A Time Synthesizer, pulse width 5 nS-160 mS, jitter<200pS	\$2,000.00



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AUDIO & BASEBAND

SPECTRUM ANALYZERS

HP 3581A Wave Analyzer, 15 Hz-50 kHz	\$750.00
HP 8556A LF Section, 20 Hz-300 kHz	\$500.00

DISTORTION ANALYZERS

HP 334A Distortion Analyzer, 5 Hz-600 kHz, -60 dB, auto nulling	\$550.00
HP 339A Distortion Analyzer, built-in low distortion osc.	\$2,400.00
TEK DA4084 Programmable Distortion Analyzer, 0.0025% THD, w/frame	\$1,500.00

RMS VOLTMETERS

FLUKE 8920A True RMS Voltmeter, 180 uV-700V, 10 Hz-20 MHz	\$700.00
FLUKE 8921A True RMS Voltmeter, 180 uV-700V, 2 Hz-2 MHz	\$700.00
HP 3400A RMS Voltmeter, 10 Hz-10 MHz	\$250.00
HP 400FL AC Voltmeter, 100 uV-300 V f.s., 20 Hz-4 MHz	\$200.00

OSCILLATORS

FLUKE 6011A Synthesized Generator, 10 Hz-11 MHz, 10 Hz res.	\$1,200.00
HP 204D Oscillator, 5 Hz-1.2 MHz, 5V RMS, 80 dB step attenuator	\$200.00
HP 209A Sine/Square Wave Generator, 4 Hz-2 MHz, 5V RMS max.	\$225.00
HP 652A Test Oscillator, 10 Hz-10 MHz	\$300.00
ROCKLAND 5100 Synthesizer, 1 mHz-1.999999999 MHz	\$350.00
TEK SG502 Sine/Square Osc., 5 Hz-500 kHz, 70 dB step atten., TM500	\$350.00
TEK SG505-opt.01 Low Distortion Oscillator, 10 Hz-100 kHz, intermod. opt.	\$1,000.00

MISCELLANEOUS

HP 3575A-002 Phase-Gain Meter, 1 Hz-13 MHz, dual display	\$900.00
HP 4437A Step Attenuator, 0-119.9 dB, DC-1 MHz, 600 ohms unbal.	\$200.00
KROHN-HITE 3202/3202R Dual High-Pass/Low-Pass Filter, 20 Hz-2 MHz, 24 dB/oct	\$600.00
KROHN-HITE 3342 Dual HP/LP Filter, 0.001 Hz-99.9 kHz, 48 dB/octave	\$1,100.00
TEK AM502 Differential Amplifier, 0.1 Hz-1 MHz, TM500 series	\$575.00

RF & MICROWAVE

SPECTRUM ANALYZERS

HP 11970A WR28 Harmonic Mixer, 26.5-40 GHz	\$1,100.00
HP 11970Q WR22 Harmonic Mixer, 33-50 GHz	\$1,400.00
HP 11970U WR19 Harmonic Mixer, 40-60 GHz	\$1,400.00
HP 11971A WR28 Harmonic Mixer, 26.5-40.0 GHz, for 8569B	\$1,100.00
HP 11971K WR42 Harmonic Mixer, 18.0-26.5 GHz, for 8569B	\$1,100.00
HP 5371A Modulation Domain Analyzer, 125 mHz-500 MHz	\$4,000.00
HP 8406A Comb Generator, 1/10/100 MHz increments, to 5 GHz	\$450.00
HP 8444A Tracking Generator, 0.1-1300 MHz, for 8554B	\$800.00
HP 8444A-059 Tracking Generator, 0.5-1500 MHz, for 8554, 8568, etc.	\$1,500.00
HP 8445B Preselector, 1.8-18.0 GHz, for HP 8555A	\$800.00
HP 8552B IF Section, 10 Hz-1250 MHz, 100 Hz resolution	\$750.00
HP 8553B RF Section, 1 kHz-110 MHz	\$500.00
HP 8554B RF Section, 0.1-1250 MHz	\$800.00
HP 8554B/8552B/141T Spectrum Analyzer, 100 kHz-1250 MHz, 100 Hz resolution	\$2,000.00
HP 8555A RF Section, 0.01-18 GHz	\$950.00
HP 8555A/8552B/141T Spectrum Analyzer System, 10 MHz-18 GHz, 100 Hz res.	\$2,250.00
HP 8555A/8552B/8445/141 As above, w/1.8-18 GHz Preselector, opt.003 freq. display	\$3,000.00
HP 8558B/181TR Spectrum Analyzer, 0.1-1500 MHz, 1 kHz res., w/display	\$2,250.00
HP 8559A/853A Spectrum Analyzer, 10 MHz-21 GHz, 1 kHz res., w/display	\$5,500.00
TEK 496P Spectrum Analyzer, 10 kHz-1.8 GHz, 30 Hz res., GPIB	\$5,500.00
TEK 7L18/7603 Spectrum Analyzer, 1.5-18.0 GHz, 30 Hz res., w/display	\$3,400.00
TEK TR503 Tracking Generator, 0.1-1800 MHz, for 492/4/5/6	\$1,375.00

NETWORK ANALYZERS

HP 11590A Bias Network, 1.0-12.4 GHz, N(f/f)	\$375.00
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7	\$450.00
HP 11665B Modulator, 0.15-18.0 GHz, for use with 8755/6/7	\$375.00
HP 11666A Reflectorometer Bridge, 0.04-18 GHz, for 8755/8756	\$1,200.00
HP 8407A/8412A/8601A Network Analyzer, 100 kHz-110 MHz, with sweep generator	\$1,250.00
HP 85027E Directional Bridge, 10 MHz-26.5 GHz, for 8757 series	\$2,000.00
HP 85050D APC7 Calibration Kit, for 8510 series	\$1,100.00
HP 8505A-005/8503A Network An., 0.5-1300 MHz, w/S-Parameter & phase lock	\$5,000.00
HP 8755C(3)/11664A/182T Scalar Network An. w/3 detectors, 10 MHz-18 GHz & frame	\$1,750.00
HP 8756A(3)/11664A Scalar Network Analyzer, w/3 detectors, 0.01-18 GHz	\$3,750.00
NARDA 7000A/7202/7206 Microwave Multimeter System: scalar analysis 0.1-18 GHz	\$1,950.00
WILTRON 560/(3)560-7S50 Scalar Network Analyzer, w/3 detectors, 0.01-18.5 GHz	\$1,750.00
WILTRON 640/G50/E(2)/7B50(2) Network An., w/1-1500 MHz source, (2) log amp, (2) det.	\$1,675.00

SIGNAL GENERATORS

FLUKE 6060A/AN Synthesized Signal Gen., 10 kHz-520 MHz, 10 Hz res, GPIB	\$2,000.00
GIGATRONICS 600/10-18, opt.06 Synthesized Source, 10-18 GHz, 1 MHz res., OCXO, GPIB	\$3,000.00
GIGATRONICS 605/0.01-8.0, opt.3 Synthesized Source, 10 MHz-8 GHz, 1 kHz res., GPIB	\$3,000.00

GIGATRONICS 875/50 Levelled Multiplier, x4, 50.0-75.0 GHz output, -3 dBm	\$3,500.00
GIGATRONICS 875/86 Levelled Multiplier, 26.5-40.0 & 50.0-75.0 GHz outputs	\$7,000.00
GIGATRONICS 910/12-18, opt.6, 14, 16 Synthesized Source/Sweeper, 12-18 GHz, 1 Hz res., OCXO	\$3,500.00
HP 85100V Frequency Mult., 10-15 GHz in / 50-75 GHz out >0 dBm	\$4,250.00
HP 8616A Signal Generator, 1.8-4.5 GHz	\$450.00
HP 8640B Signal Generator, 0.5-512 MHz, AM, FM	\$1,500.00
HP 8640B-001,002,003 Signal Gen., 0.5-1024 MHz, AM, FM, var. audio osc.	\$2,750.00
HP 8654A Signal Generator, 10-520 MHz, calibrated AM & uncal. FM	\$625.00
HP 8656A Signal Generator, 0.1-990 MHz, AM, FM, HPIB	\$2,900.00
HP 8660C/86602B/86632B Synthesized Signal Generator, 1-1300 MHz, AM, FM	\$2,750.00
HP 8660C/86603A/86632B Synth. Sig. Gen., 1-2600 MHz, AM, FM, digital sweep	\$4,500.00
HP 8672A Synthesized Signal Generator, 2.0-18.0 GHz	\$10,000.00
WILTRON 6742A Synthesizer/Sweep Generator, 18.0-26.5 & 26.5-40.0 GHz	\$9,000.00

SWEEP GENERATORS

GIGATRONICS 900/0.05-12, opt.3 Synthesized Sweep/Sig. Gen., 50 MHz-12 GHz, 1 kHz res	\$4,500.00
HP 8350A/86290B-H08 Programmable Sweep System, 2.0-22.0 GHz, +4 dBm lvd	\$5,500.00
HP 8600A Digital Marker, for HP 8601A	\$400.00
HP 8601A Generator/Sweeper, 0.1-110 MHz, +20 dBm levelled	\$500.00
HP 8620C Sweep Oscillator Frame	\$550.00
HP 8620C-011 Sweep Oscillator Frame, HPIB programmable	\$675.00
HP 86220A RF Plug-in, 10-1300 MHz, +10 dBm levelled	\$800.00
HP 86222B RF Plug-in, 10-2400 MHz, +13 dBm levelled, x1al markers	\$1,500.00
HP 86222B-002 RF Plug-in, 10-2400 MHz, crystal markers, 0-70 dB atten	\$1,750.00
HP 86230B RF Plug-in, 1.8-4.2 GHz, +10 dBm unlevelled	\$675.00
HP 86240A RF Plug-in, 2.0-8.4 GHz, +16 dBm levelled	\$1,000.00
HP 86240A-002 RF Plug-in, 2.0-8.4 GHz, +14 dBm lvd., 70 dB step att.	\$1,200.00
HP 86240B RF Plug-in, 2.0-8.4 GHz, +13 dBm levelled	\$1,000.00
HP 86241A-001 RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled	\$500.00
HP 86242D-004,008 RF Plug-in, 5.9-9.0 GHz, +10 dBm levelled	\$500.00
HP 86245A RF Plug-in, 5.9-12.4 GHz, +16 dBm levelled	\$1,100.00
HP 86260A RF Plug-in, 12.0-18.0 GHz, +10 dBm unlevelled	\$800.00
HP 86260A-H04 RF Plug-in, 10.0-15.0 GHz, +10 dBm unlevelled	\$800.00
HP 86290A RF Plug-in, 2.0-18.0 GHz, +7 dBm levelled	\$1,750.00
HP 86290B RF Plug-in, 2.0-18.6 GHz, +10 dBm levelled	\$2,250.00
HP 86290C RF Plug-in, 2.0-18.6 GHz, +13 dBm levelled	\$2,500.00
WAVETEK 1001A Sweep Generator, 0.5-300 MHz	\$350.00
WAVETEK 907 Sweep/Signal Generator, 7.0-11.0 GHz, 0 dBm levelled	\$1,000.00
WAVETEK 962 Sweep Generator, 1.0-4.0 GHz, markers, +12 dBm unlvld.	\$2,000.00
WILTRON 6647A-02 Sweep Gen., 0.01-18.6 GHz, +14 dBm levelled, 70 dB atten.	\$6,500.00

POWER METERS

BOONTON 4200-01B/-4G Power Meter w/sensor, 1 MHz-26.5 GHz, -60 to +10 dBm, GPIB	\$1,500.00
BOONTON 42B/41-4E Analog Power Meter, with 1 MHz-18 GHz sensor	\$500.00
BOONTON 42B/42A-S3 Analog Power Meter, with 1 MHz-8.4 GHz N(f) sensor	\$375.00
GENERAL MICROWAVE 476/4240A Power Meter & Sensor, 0.01-18 GHz, -35 to +10 dBm	\$375.00
HP 11683A Range Calibrator, for HP 435/6/7/8	\$750.00
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HP 435A/8484A Power Meter, 10 MHz-18 GHz, -70 to -20 dBm	\$1,000.00
HP 436A Digital Power Meter	\$1,200.00
HP 436A-022 Digital Power Meter, HPIB option	\$1,400.00
HP K486A WR42 Thermistor Mount, 18.0-26.5 GHz, for 432 series	\$400.00
HP Q8486A Power Sensor, 33.0-50.0 GHz, WR22, for 435/6/7/8	\$1,500.00
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HP K532A WR42 Frequency Meter, 18.0-26.5 GHz	\$500.00
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Data Conversion (A/D and D/A)

Part 2

Types of A/D Converters

The analog-to-digital converter (A/D) is used to convert an analog voltage or current input to an output binary word that can be used by a computer. Of the many techniques that have been published for performing an A/D conversion, only a few are of interest to us; so we will consider only the voltage-to-frequency, single-slope integrator, dual-slope integrator, counter (or servo), successive approximation, and flash methods. The basic size of circuit that we will show is the eight-bit A/D converter, which for many purposes is all that is needed. These same discussions are also useful for 10-bit, 12-bit, or higher order A/D converters.

Integration A/D Methods

Most digital panel meters (DPM) and digital multimeters (DMM) use either the single integration or dual-slope integration methods for the A/D conversion process. An example of a single-slope integrator A/D converter is shown in Figure 1A, while its timing diagram is shown in Figure 1B. The single-slope integrator is simple, but is limited to those applications that can tolerate accuracy of one or two percent.

The single-slope integrator A/D converter of Figure 1A consists of five basic sections: ramp generator, comparator, logic, clock, and output encoder. The ramp generator is an ordinary operational amplifier Miller integrator with its input connected to a stable, fixed, reference voltage source. This makes the input current I_{ref} essentially constant; so the voltage at point-B will rise in a nearly linear manner, creating the voltage ramp.

The comparator is an operational amplifier that has an open feedback loop. The circuit gain is the open-loop gain (A_{vol}) of the device

selected — typically very high even in low-cost operational amplifiers. When the analog input voltage V_x is greater than the ramp voltage, the output of the comparator is saturated at a logic-HIGH level.

The logic section consists of a main AND gate, a main-gate generator, and a clock. The waveforms associated with this circuit are shown in Figure 1B. When the output of the main-gate control logic section is LOW, switch S1 remains closed, so the ramp voltage is zero. The main-gate signal at point-A is a low-frequency squarewave with a frequency equal to the desired time-sampling rate. When point-A is HIGH, S1 is open, so the ramp will begin to rise linearly. When the ramp voltage is equal to the unknown input voltage V_x , the differential voltage seen by the comparator is zero; so its output drops LOW.

The AND gate requires all three inputs to be HIGH before its output can be HIGH also. The output of the AND

gate will go HIGH every time the clock signal is also HIGH.

The encoder (in this case an eight-bit binary counter) will then see a pulse train with a length proportional to the amplitude of the analog input voltage. If the A/D converter is

designed correctly, then the maximum count of the encoder will be proportional to the maximum range (full-scale) value of V_x .

Several problems are found in single-slope integrator A/D converters:

- The ramp voltage may be non-linear.
- The ramp voltage may have too steep or too shallow a slope.
- The clock pulse frequency could be wrong.

Open Channel

by Joseph J. Carr
K4IPV

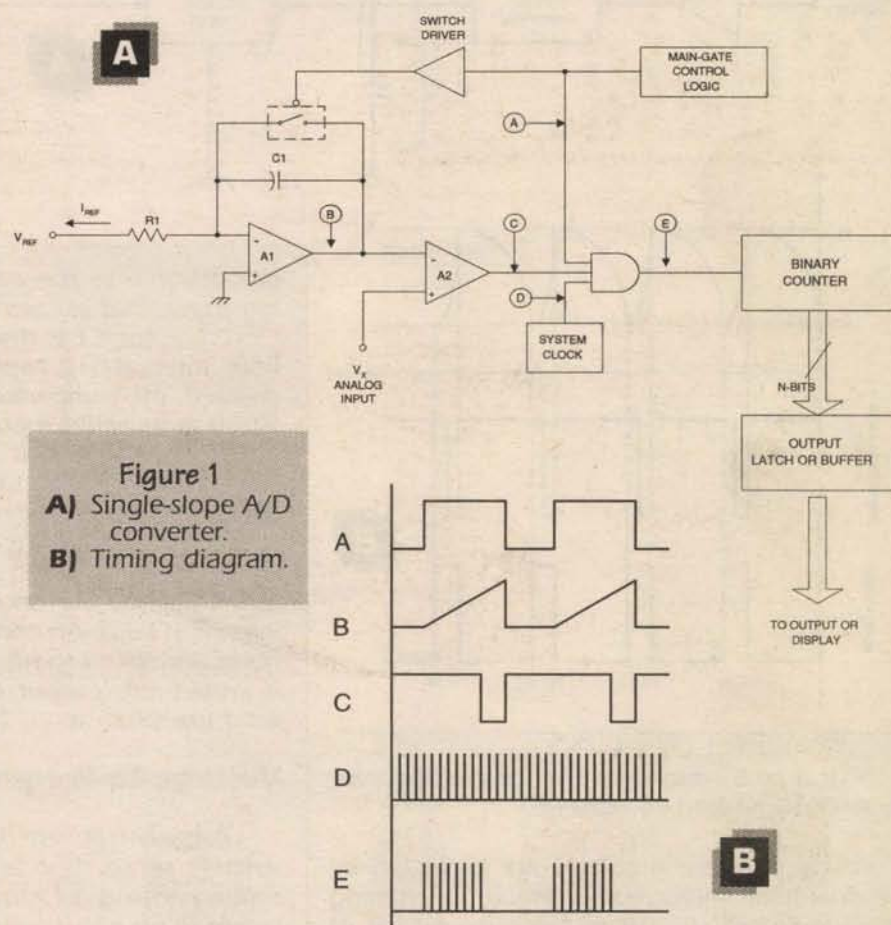


Figure 1
A) Single-slope A/D converter.
B) Timing diagram.

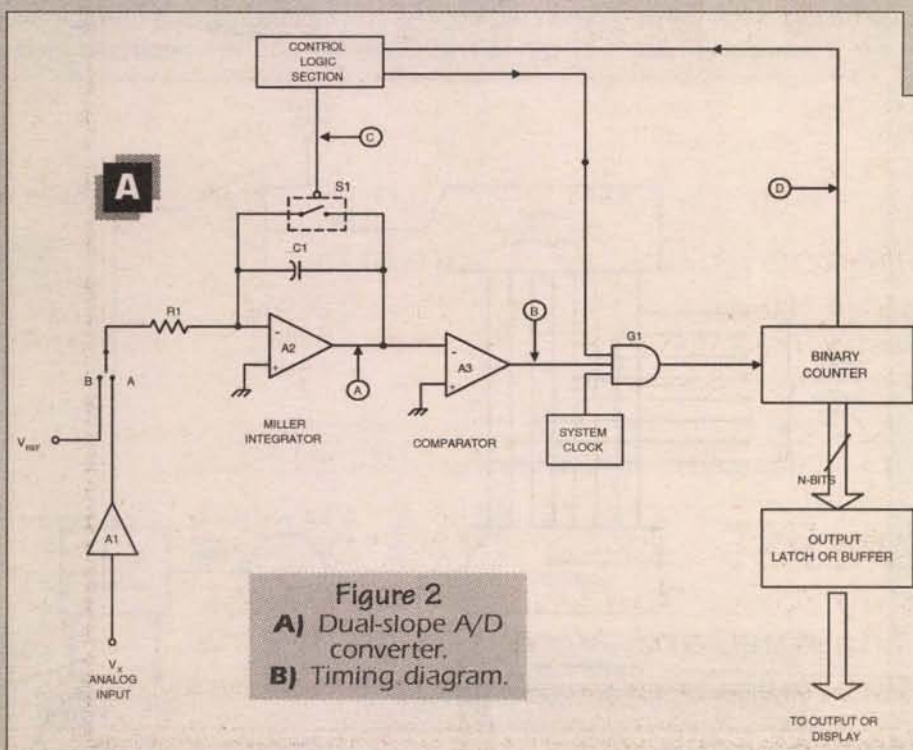
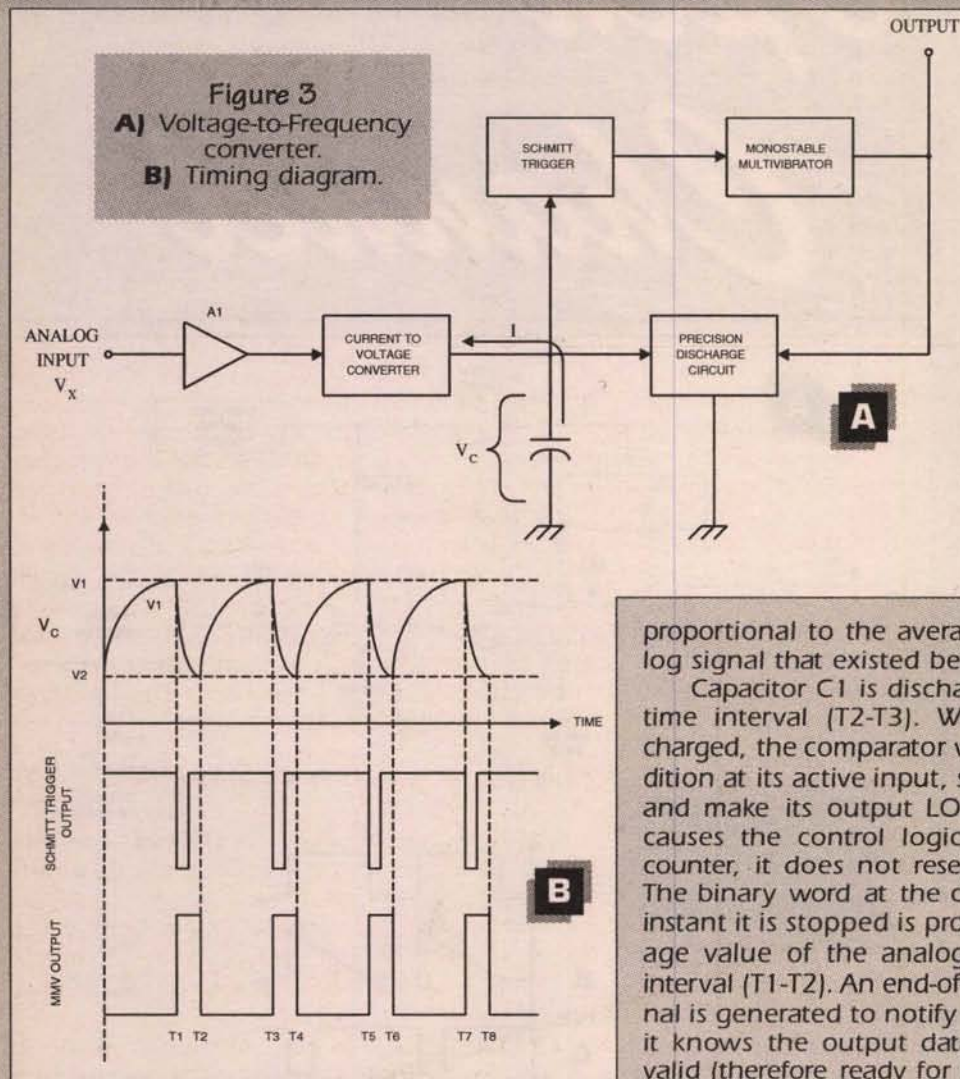


Figure 2
A) Dual-slope A/D converter.
B) Timing diagram.



precision reference source. Meanwhile, at time T2 the counter had overflowed, and again it has an output of 00000000₂ (maximum counter + 1 more count is the same as the initial condition). It will, however, continue to increment so long as we have a HIGH comparator output. The charge accumulated on capacitor C1 during the first time interval is

proportional to the average value of the analog signal that existed between T1 and T2.

Capacitor C1 is discharged during the next time interval (T2-T3). When C1 is fully discharged, the comparator will see a ground condition at its active input, so it will change state and make its output LOW. Even though this causes the control logic to stop the binary counter, it does not reset the binary counter. The binary word at the counter output at the instant it is stopped is proportional to the average value of the analog waveform over the interval (T1-T2). An end-of-conversion (EOC) signal is generated to notify the computer so that it knows the output data is both stable and valid (therefore ready for use).

- It may be prone to changes in apparent value of V_x caused by noise.

Many of these problems are corrected by the dual-slope integrator of Figure 2A (timing circuit in Figure 2B). This circuit also consists of five basic sections: integrator, comparator, control logic section, binary counter, and a reference current or voltage source. An integrator is made with an operational amplifier connected with a capacitor in the negative feedback loop, as was the case in the single-slope version. The comparator in this circuit is also the same sort of circuit as was used in the previous example. In this case, though, the comparator is ground-referenced by connecting +IN to ground.

When a start command is received, the control circuit resets the counter to 00000000₂, resets the integrator to 0 volts (by discharging C1 through switch S1), and sets electronic switch S2 to the analog input (position-A). The analog voltage creates an input current to the integrator which causes the integrator output to begin charging capacitor C1; the output voltage of the integrator will begin to rise. As soon as this voltage rises a few millivolts above ground potential (0 VDC), the comparator output snaps HIGH-positive. A HIGH comparator output causes the control circuit to enable the counter, which begins to count pulses.

The counter is allowed to overflow, and this output bit sets switch S2 to the reference source (position-B). The graph of Figure 2B shows the integrator charging during the interval between start and the overflow of the binary counter. At time T2, the switch changes the integrator input from the analog signal to a

Voltage-to-Frequency Converters

These circuits are not A/D converters in the strictest sense, but are very good for representing analog data in a form that can be tape recorded on a low-cost audio machine, or transmitted over radio. The V/F converter output can also be used for direct input to a computer if a binary counter is used to measure the output frequency. Two forms of V/F converter are common. One is a voltage controlled oscillator (VCO); that is, a regular oscillator circuit in which the output frequency is a function of an input control voltage. If the VCO is connected to a binary or binary-coded decimal (BCD) counter, then the VCO becomes a V/F form of A/D converter.

The type of V/F converter shown in Figure 3 is superior to the VCO method. The circuit is shown in Figure 3A, while the timing waveforms are shown in Figure 3B. The operation of this circuit is dependent upon the charging of a capacitor, although not an RC network, as in the case of some other oscillator or timer circuits. The input voltage signal (V_x) is amplified (if necessary) by A1, and

then converted to a proportional current level in a voltage-to-current converter stage. If the voltage applied to the input remains constant, so will the current output of the V-to-I converter (I).

The current from the V-to-I converter is used to charge the timing capacitor, C. The voltage appearing across this capacitor (V_c) varies with time as the capacitor charges (see the V_c waveform in Figure 3B). The precision discharge circuit is designed to discharge capacitor C to a certain level (V_2) whenever the voltage across the capacitor reaches a predetermined value (V_1).

When the voltage across the capacitor reaches V_2 , a Schmitt Trigger circuit is fired that turns on the precision discharge circuit. The precision discharge circuit, in its turn, will cause the capacitor to discharge rapidly, but in a controlled manner to value V_1 . The output pulse snaps HIGH when the Schmitt Trigger fires (i.e., the instant V_c reaches V_1) and drops LOW again when the value of V_c has discharged to V_2 . The result is a train of output pulses whose repetition rate is exactly dependent upon the capacitor charging current, which, in turn, is dependent upon the applied voltage. Hence, the circuit is a voltage-to-frequency converter.

Like the VCO circuit, the output of the V/F converter can be applied to the input of a binary counter. The parallel binary outputs become the data lines to the computer. Alternatively, if the frequency is relatively low, the computer can be programmed to measure the period between pulses. Also, certain computer interface chips have built-in timers that can measure the period.

Counter Type (Servo) A/D Converters

A counter type A/D converter (also called "Servo" or "ramp" A/D converters) is shown in Figure 4. It consists of a comparator, voltage output DAC, binary counter, and the necessary control logic. When the start command is received, the control logic resets the binary counter to 00000000₂, enables the clock, and begins counting. The counter outputs control the DAC inputs; so the DAC output voltage will begin to rise when the counter begins to incre-

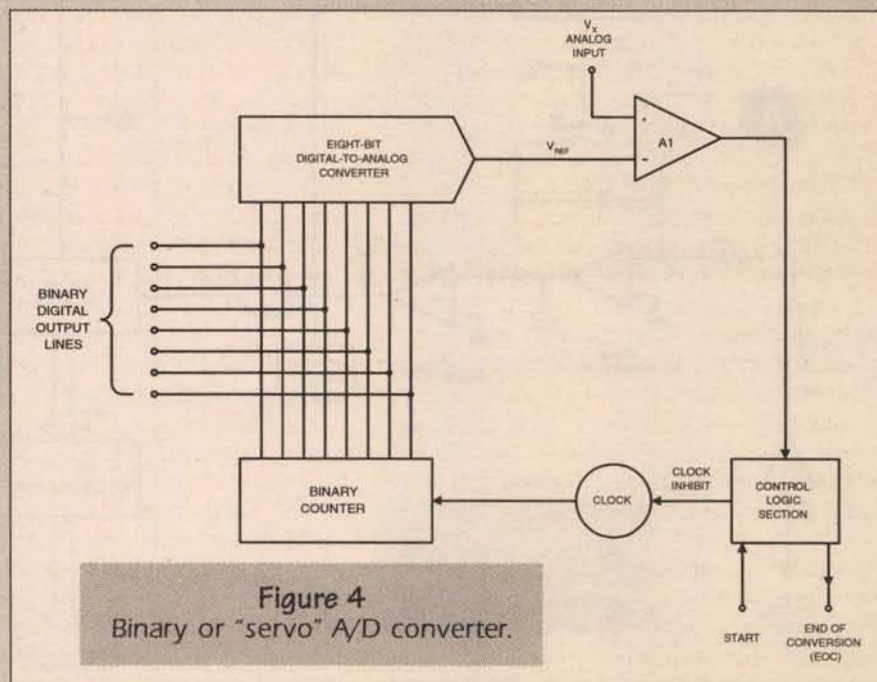


Figure 4
 Binary or "servo" A/D converter.

Open Channel

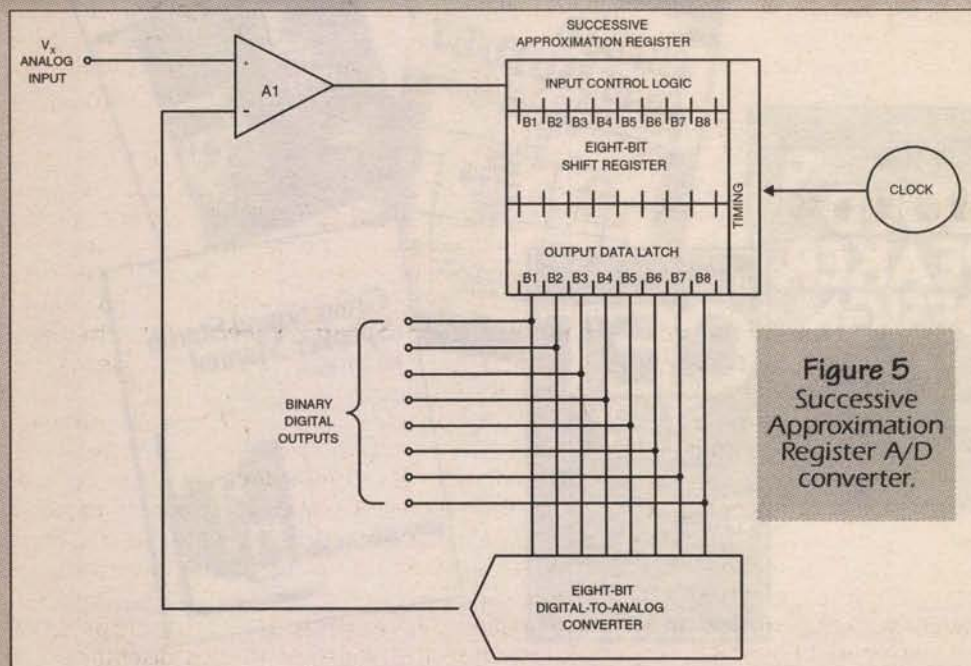


Figure 5
Successive
Approximation
Register A/D
converter.

of the conversion process after fewer cycles if the final value is found prior to $N + 1$ cycles.

The successive approximation converter operates by making several successive trials at comparing the analog input voltage with a reference generated by a DAC. An example is shown in Figure 5. This circuit consists of a comparator, control logic section, a digital shift register, output latch-

es, and a voltage output DAC.

When a START command is received, a binary 1 (HIGH) is loaded into the MSB of the shift register, and this sets the output of the MSB latch HIGH. A HIGH in the MSB of a DAC will set the output voltage V_{ref} to half-scale. If the input voltage V_{in} is greater than V_{ref} , the comparator output stays HIGH and the HIGH in the shift register MSB position shifts one-bit to the right, and therefore occupies the next most significant bit (bit 2). Again, the comparator compares V_{in} with V_{ref} . If the reference voltage from the DAC is still less than the analog input voltage, the process will be repeated with suc-

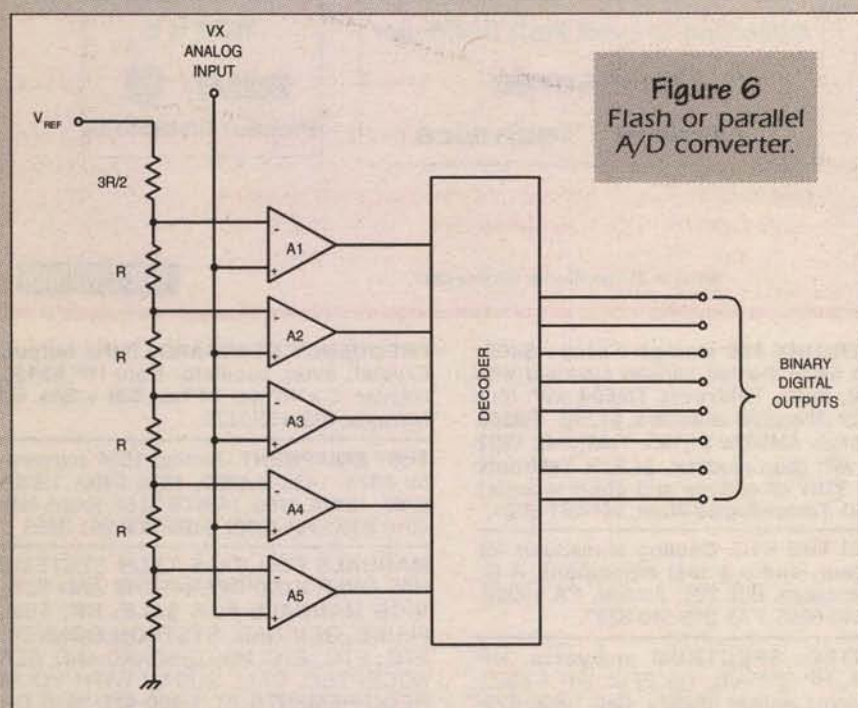


Figure 6
Flash or parallel
A/D converter.

cessively less significant bits until either a voltage is found that is equal to V_{in} (in which case, the comparator output drops LOW) or the shift register overflows.

If, on the other hand, the first trial with the MSB indicates that V_{in} is less than the half-scale value of V_{ref} , the circuit continues making trials below V_{ref} . The MSB latch is reset to LOW and the HIGH in the MSB shift register position shifts one-bit to the right to the next most significant bit (bit-2). Here the trial is repeated again. This process will continue as before until either the correct level is found, or overflow occurs. At the end of the last trial (bit-8 in this case), the shift register overflows and the overflow bit becomes an end-of-conversion (EOC) flag to tell the rest of the world that the conversion is completed.

This type, and most other types of A/D converters, requires a starting pulse and signals completion with an EOC pulse. This requires the computer or other digital instrument to engage in bookkeeping to repeatedly send the start command and look for the EOC pulse. If the start input is tied to the EOC output, then conversion is continuous, and the computer

need only look for the periodic raising of the EOC flag to know when a new conversion is ready. Such operation is said to be asynchronous.

Parallel or "Flash" A/D Converters

The parallel A/D converter (Figure 6) is probably the fastest A/D circuit known. Indeed, the very fastest ordinary commercial products use this method. Some sources call the parallel A/D converter the "flash" circuit because of its inherent high speed.

The parallel A/D converter consists of a bank of $[2^N - 1]$ voltage comparators biased by reference potential V_{ref} through a resistor network that keeps the individual comparators 1-LSB apart. Since the input voltage is applied to all the comparators simultaneously, the speed of conversion is limited essentially by the slow rate of the slowest comparator in the bank, and also by the decoder circuit propagation time. The decoder converts the output code to binary code needed by the computers.

Summary of A/D Converters

1. An analog-to-digital (A/D) converter produces a binary number output that represents the applied analog input voltage or current. A digital-to-analog converter (DAC) is exactly the opposite: it outputs an analog voltage or current that is proportional to an applied binary number.

2. Most DAC designs are based on the R-2R binary weighted ladder. If the output is unterminated, then the DAC is a current output type; if the output is terminated in either a load resistor or an operational amplifier, then the DAC is a voltage output type.

3. Several different coding schemes are used in data converters; unipolar positive, unipolar negative, symmetrical bipolar, and asymmetrical bipolar are the most common.

4. IC DACs can be used to generate waveforms. If the DAC digital inputs are incremented by an ordinary binary counter, then a sawtooth is generated; if incremented by an up/down counter, then a triangle waveform is generated; if the binary inputs are driven from a Read Only Memory (ROM), that is, in turn, driven by a binary counter used as an address generator, then any waveform whose binary bit pattern can be stored in ROM can be created.

5. Several different approaches are used for A/D conversion: voltage-to-frequency converter, single-slope integrator, dual-slope integrator, counter (or servo), successive approximation, and flash methods.

Next Month ...

Next month, we will conclude the series on A/D converters with a look at some practical examples of circuits you can build, or products that you can buy. I own and use several different A/D converters, and will demonstrate some of them to you. **NV**

Connections

I can be reached at P.O. Box 1099, Falls Church, VA 22041, or via E-Mail at carrjj@aol.com

Successive Approximation A/D Converters

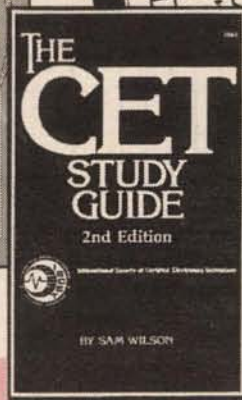
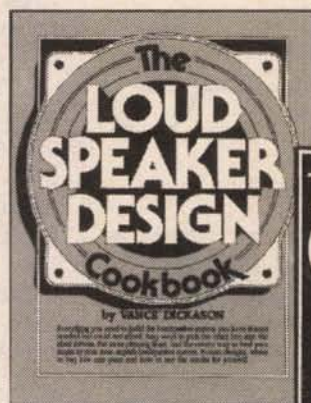
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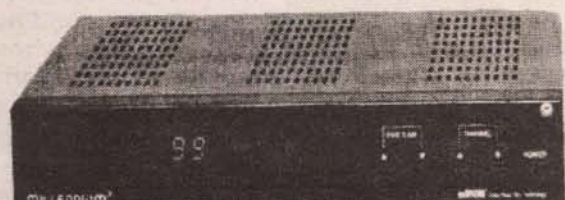
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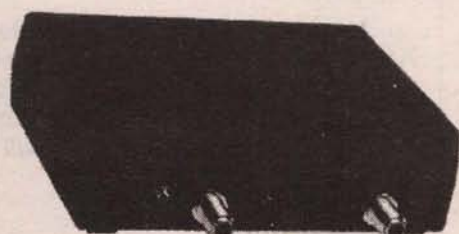
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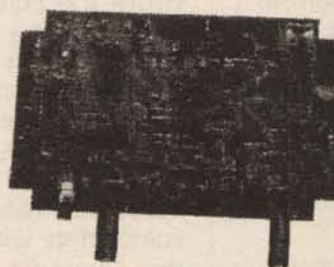
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New Orleans 70130

MARYLAND

C.S.A. Paging & Cellular
700 Mace Ave., Store B
Baltimore 21221

Silicon Valley Electronics
2014-A Industrial Drive
Annapolis 21401

Tower Records/Video
2566 Solomons Island Road
Annapolis 21401

1601 Rockville Pike #210
Rockville 20852

MICHIGAN

Family Electronics
111 E. Superior St.
Alma 48801

Little Professors Book Center
22174 Michigan Ave.
Dearborn 48124

MW Electronics
229 E. Michigan Ave.
Paw Paw 49079

Purchase Radio Supply, Inc.
327 E. Hoover Ave.
Ann Arbor 48104

Radio Shack
1332 U.S. Hwy 41 West
Ishpeming 49849

Tower Records
1214 S. University Ave.
Ann Arbor 48104

MINNESOTA

Radio City, Inc.
2633 County Road 1
Mounds View 55112

MISSOURI

Accurate Instruments
11201 E. 24 Highway
Independence 64054

Electronics Exchange
8644 St. Charles Rock Road
St. Louis 63114

Stewart & Associates
204 Sonderen St.
O'Fallon 63366

NEBRASKA

Ladd Electronics Co.
111 N. 41st St.
Omaha 68131

NEVADA

Amateur Electronic Supply
1072 N. Rancho Drive
Las Vegas 89106

Less Buster's Electronics
2930 N. Las Vegas Blvd.
VSTG-22
North Las Vegas 89030

Radio World
1656 Nevada Hwy
Boulder City 89005

Tower Records/Video
4580 W. Sahara Ave.
Las Vegas 89102

6450 South Virginia
Reno 89511

NEW JERSEY

JR Tech Systems
1309 Highway 71
Belmar 07719

Tower Records
809 Route 17 South
Paramus 07652

NEW YORK

All Phase Video Security, Inc.
70 Cain Drive
Brentwood 11717

Ham Central
3 Neptune Road
Poughkeepsie 12601

Tony's Equipment
10065 Morley Road
North Collins 14111

Tower Records/Video
105 Old Country Road
Carle Place 11514

350-370 Route 110
Huntington 11746

383 Lafayette St.
New York 10003

OHIO

Compustuff
2751 Medina Road
Medina 44258

Footsteps
4925 Jackman Rd. Store #58
Toledo 43613

Hosfelt Electronics, Inc.
2700 Sunset Blvd.
Steubenville 43952

Keyways, Inc.
611 S. Main St.
Miamisburg 45342

Leo's Book Shop
330 N. Superior St.
Toledo 43604

Powermaxx, Inc.
1587 U.S. Route 68 North
Xenia 45385

OREGON

News & Smokes
2295 W. Main St.
Medford 97501

News & Smokes #8
259-C Barnett Road
Medford 97501

Norvac Electronics
7940 SW Nimbus Ave. Bldg. 8
Beaverton 97005

960 Conger
Eugene 97402

1545 N. Commercial NE
Salem 97303

Powell's Technical Bookstore
33 NW Park
Portland 97209

Tower Books
1307 NE 102nd Ave.
Portland 97220

PENNSYLVANIA

Lehman Scientific
2997-F Cape Horn Road
Red Lion 17356

Penn Electronics
2310 A Walnut St.
Harrisburg 17103

Tower Books
425 South St.
Philadelphia 19147

Tower Records
340 W. Dekalb Pike
King of Prussia 19406

PUERTO RICO

Marval Security Equipment
Calle 6 #13, Ext. San Agustin
Rio Piedras 00926

SOUTH CAROLINA

555 Electronics
5646 Farrow Road
Columbia 29203

TENNESSEE

Tower Books
204 West End Ave.
Nashville 37203

TEXAS

Tanner Electronics
1301 W. Beltline #105
Carrollton 75006

The Communication Source
2713 Galleria Drive
Arlington 76011

Tower Records
2403 Guadalupe
Austin 78705

UTAH

Omega Electronics
1500 North 150 West
Provo 84604

VIRGINIA

Electronic Equipment Bank
323 Mill Street NE
Vienna 22180

Riley's Distributing
1045 Edom Road
Harrisonburg 22801

Satellite Headquarters
7920 Timberlake Road
Lynchburg 24502

Tower Records/Video/Books
4110 W. Ox Road #12124
Fairfax 22033

1601 Willow Lawn Drive
Richmond 23230

WASHINGTON

A-B-C Communications, Inc.
17541 15th Avenue NE
Seattle 98155

Amateur Radio Supply Co.
5963 Corson Ave. S. #140
Seattle 98108

Supertronix
18650 68th Avenue South
Kent 98032

Tower Books
10635 NE 8th St.
Bellevue 98004

20 Mercer St.
Seattle 98109

2501 S. 38th St.
Tacoma 98409

WISCONSIN

Amateur Electronic Supply, Inc.
5710 W. Good Hope Road
Milwaukee 53223

Little Professor Book Center
307 N. Bridge St.
Chippewa Falls 54729

News & Hobby Center
4758 Packard Ave.
Cudahy 53110

Build the SentryStrobe



ome security is extremely important for one's peace of mind. Consider this scenario: It's midwinter and you're happily vacationing in sunny Florida. Back at your Connecticut home, the outside temperature is -2 F, inside it's 55 F (because you turned the thermostat down). In the cellar, the stack control on the furnace silently malfunctions, and the temperature drops down, down, down, until the pipes freeze and break and the beloved tropical fish collection goes belly up (or is it gills up?).

Don't laugh — these things happen all the time. But now you have a way to be alerted in case any of the following happens:

- Abnormal temperatures, either too hot or too cold.
- Noises that "shouldn't be there," such as children having a mock war in an isolated part of the

house where valuable possessions are kept.

- The option to attach other sensors to the project.
- The ability to flash when the phone rings, which is a real boon to the hearing impaired or for people working in noisy environments.
- You can even configure the device to scare the daylights out of any thief!

A Bright Xenon Strobe Announces Trouble

Xenon strobes have been with us for many years. They were first invented in 1932 by the late Dr. Harold E. Edgerton, who was searching for a way to "freeze" motion. His task was to research the effect of lightning and other electrical surges on utility power generators. Thus, it could be determined exactly how far they got out of phase with one another from those surges. Edgerton's invention has been invaluable and its spin-offs have given us everything from aircraft anti-collision lights, to the electronic camera flash.

Strobes output their light energy in one bright flash rather than burn continuously. So all the candle power of say, a 100-watt bulb can be emitted by a big enough strobe lamp in 1/1000th of a second, and in some cases, in a considerably less time interval. That means for this brief instant, this example lamp would be as bright as a 100,000 watt bulb! However, the brief duration of the flash prevents overheating and eye damage a continuous burning lamp would produce.

Light output is measured in units called WATT-SECONDS, or JOULES, which are the same thing. In the case of a strobe lamp, a capacitor stores a high DC voltage, from 200 to 2,000 volts, used to power the lamp.

The optimum voltage is dependent upon the physical size of the lamp and the gas pressure it's filled to. Xenon gas within is excited by this charge, and emits a broad spectrum of light ranging from infrared through the visible spectrum to ultraviolet. The short wavelength of invisible ultraviolet is blocked by the glass envelope of the lamp, while enough infrared is emitted, so interestingly, a big strobe bulb's heat can be felt on the skin while flashing. The

majority of the infrared cannot be felt, however, since the skin nerves can't react fast enough to feel it.

Only a fraction of infrared energy is felt, yet the invisible energy still exists. This interesting fact led to building an infrared light marker; a light that can be seen only by nightvision and most CCD camera equipment, but cannot be seen by the unaided eye.^{1}

But it's the visible light that counts with the SentryStrobe. Output in Watt-seconds can be calculated by the formula shown in Equation 1.

EQUATION 1

Light output in Watt-seconds is determined by:

$$W = 0.5 \cdot C \cdot V^2$$

Where: **W** is the output
0.5 the numerical constant
C the capacitance of the energy storage capacitor in microfarads and
V squared the voltage in KILovolts that the capacitor is charged to

So, the larger the capacitor, or the higher the voltage it's charged to (or both), the greater the light output. Interestingly, if the capacitance is doubled, so is the bulb's luminosity, but if the voltage is doubled for the same capacitance, the light output is quadrupled. Try a few sample calculations and note this fact.

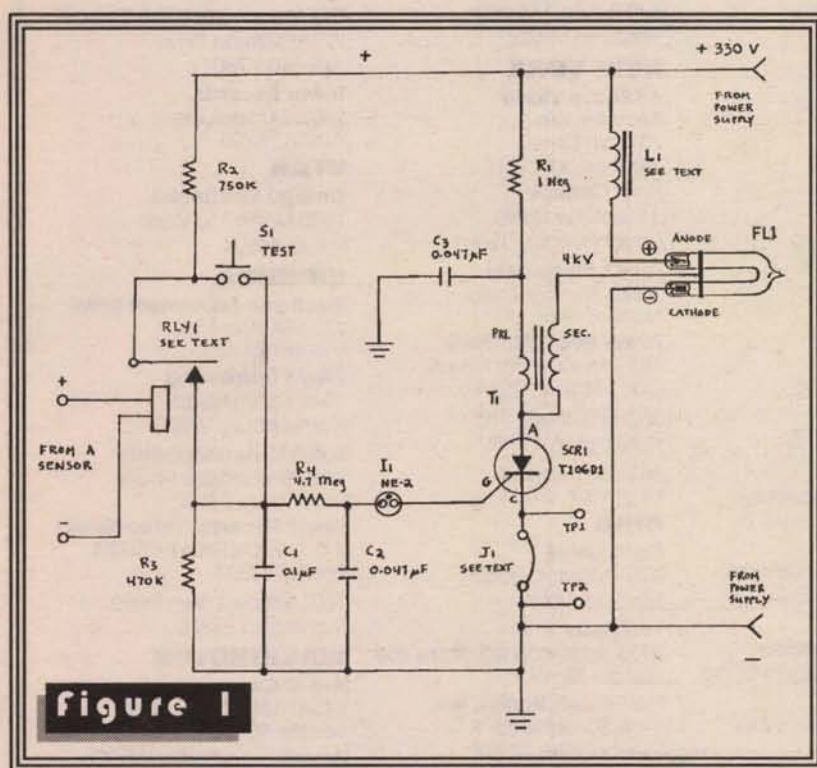
Requirements to Operate a Strobe

Strobe circuits have four main requirements. First is a source of DC power to charge the main capacitor. In our case, it will be to approximately 330 volts, obtained either from a direct AC-powered line voltage doubler or a step-up/isolation transformer, whichever produces the best combination of safety and economy. Secondly, we need that powerful capacitor to store the voltage charge. It will be either a standard HV electrolytic or a photoflash electrolytic equipped with a choke coil. More on that shortly.

Our third need is a voltage source of very high potential, producing pulses of 4,000 to 6,000 VAC. Sounds complicated and expensive, but there are small pulse transformers on the market which can satisfy this requirement for \$2.00 to \$3.00 in components. Number four on the shopping list is an appropriately-rated strobe lamp, and we'll also get to that in a moment, along with naming suppliers of such lamps.

Figure 1 shows the circuit of the SentryStrobe minus the add-on sensing modules and power supply. FL1 is the strobe bulb, whose bright flash will warn and alert of any trouble. The choke coil is

^{1} Mentioned here as it's a fascinating project of its own. A strobe with a reflector is placed behind a large surplus infrared filter, and the light that occurs on the camera monitor or nightvision 'scope can be seen for miles at night — but only to those with the IR-sensitive equipment!



used if the circuit's power supply, shown in Figure 2 uses photoflash capacitors. This is a standard fullwave voltage-doubler power supply with a voltage indicator lamp, I2.

Minus the choke, the flashlamp may emit a blueish tinted light with loss of spectral efficiency. In the prototype, L1 is a short length of AM radio antenna rod, covered with electrical tape to insulate it. Then 70 turns of #20 gauge magnet wire was wrapped around it. That gave an inductance of about 25 millihenries, adequate for the two 130 uF photoflash capacitors used in its power supply. If you require a choke, it is suggested to use 0.2 to 0.5 mH per microfarad of capacitance across FL1. Also, a heavy gauge wire should be used since the instantaneous current in the lamp can run into thousands of amperes. If the discharge was continuous, obviously the 20 gauge wire wouldn't last, but since the interval is short it does.

A reed relay is used to activate the strobe part of the circuit. A five-volt relay with a 250-ohm coil was used. The input current was adjusted from the sensors so that they activate the strobe without overdriving the coil. You'll see each sensor has an explanation of how to interface it to this relay. A special circuit generates the 4,000 volt pulse. Resistive divider R2 and R3 cut down the voltage from the power supply to about 125 volts at the input to C1. As C1 charges, a small amount of current is bled from it to a second capacitor, C2. Note the neon indicator lamp I1. I1 is a type which turns on at about 90 VDC. This is called its "striking voltage."

Once the charge on C2 builds to I1's striking voltage, it dumps C1's charge into the gate of SCR1. That component is specifically designed to be activated by a small current, and hence is known as a "sensitive gate SCR." Substitutions are not recommended. So SCR1 fires just from the small charge sent by I1.

What happens next? Well, while all this is occurring, a charge has been accumulating on C3 through R1, a 1 megohm resistor. SCR1 conducts with near zero resistance after it fires, and hence pulls a strong current for a short duration through the low-resistance primary of T1. That induces a 4,000 volt pulse in the secondary of T1, which has a much greater ratio of turns on the secondary than the primary.

The high voltage pulse is capacitively coupled to the Xenon gas mixture in FL1, and FLASH! Your strobe bulb ignites. The whole process occurs several times a second; about three times per second in our prototype. Adjustment of component values R2 and R3 are likely. So you can solder extra resistors in series if more resistance is required, or piggyback some across either component if less resistance is needed. That's because I1 is not a precision component, and the values cannot be chosen exactly in this case, however, the values shown have given good results.

Testing the Circuit

S1 and test points TP1 and TP2 are used to diagnose the circuit if it isn't working properly. S1 bypasses the relay and enables instant emulation of an alert situation, normally provided by an external sensor. Usually J1 is left intact; it can be a jumper made of lamp cord or a similar wire. First off, check I1 which will give you a visible indication of its firing. It should ignite several times per second and at a rate higher than the power supply can charge its capacitors. That is expected because we want to ignite the flashlamp faithfully without overtaxing its power supply or overheating

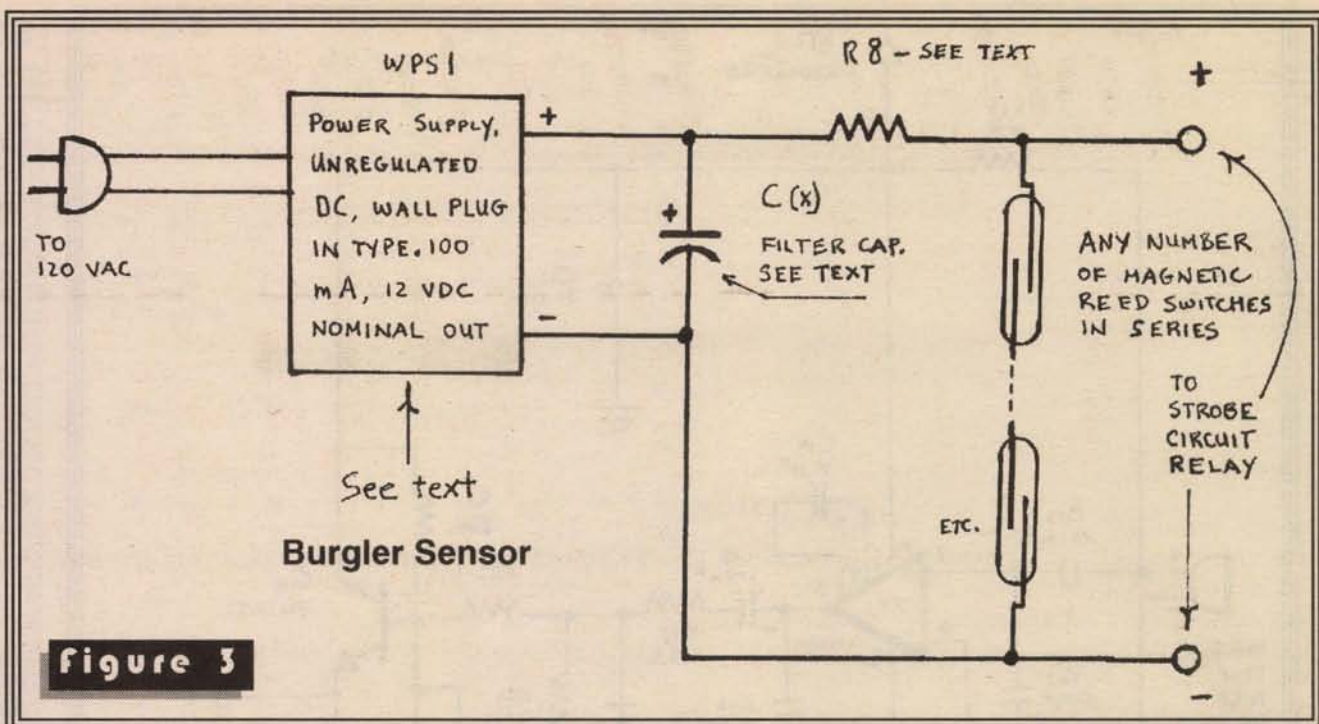


Figure 3

the lamp.

Should the lamp fail to fire, check the DC voltage across it (CAUTION!) for a reading close to 330 VDC. Ask yourself: Are you using the correct type flashlamp? Some just won't fire at 330 volts DC. Is the trigger pulse being generated? Take another neon indicator lamp, and attach a 1

megohm resistor to one lead. Hold the other in your hand, and touch the 1 megohm resistor lead to the HV output of T1. You should see a flash from the test neon lamp, and don't worry, it won't give you a shock.

If this fails, cut jumper J1 and install a small speaker across TP1 and TP2. During normal oper-

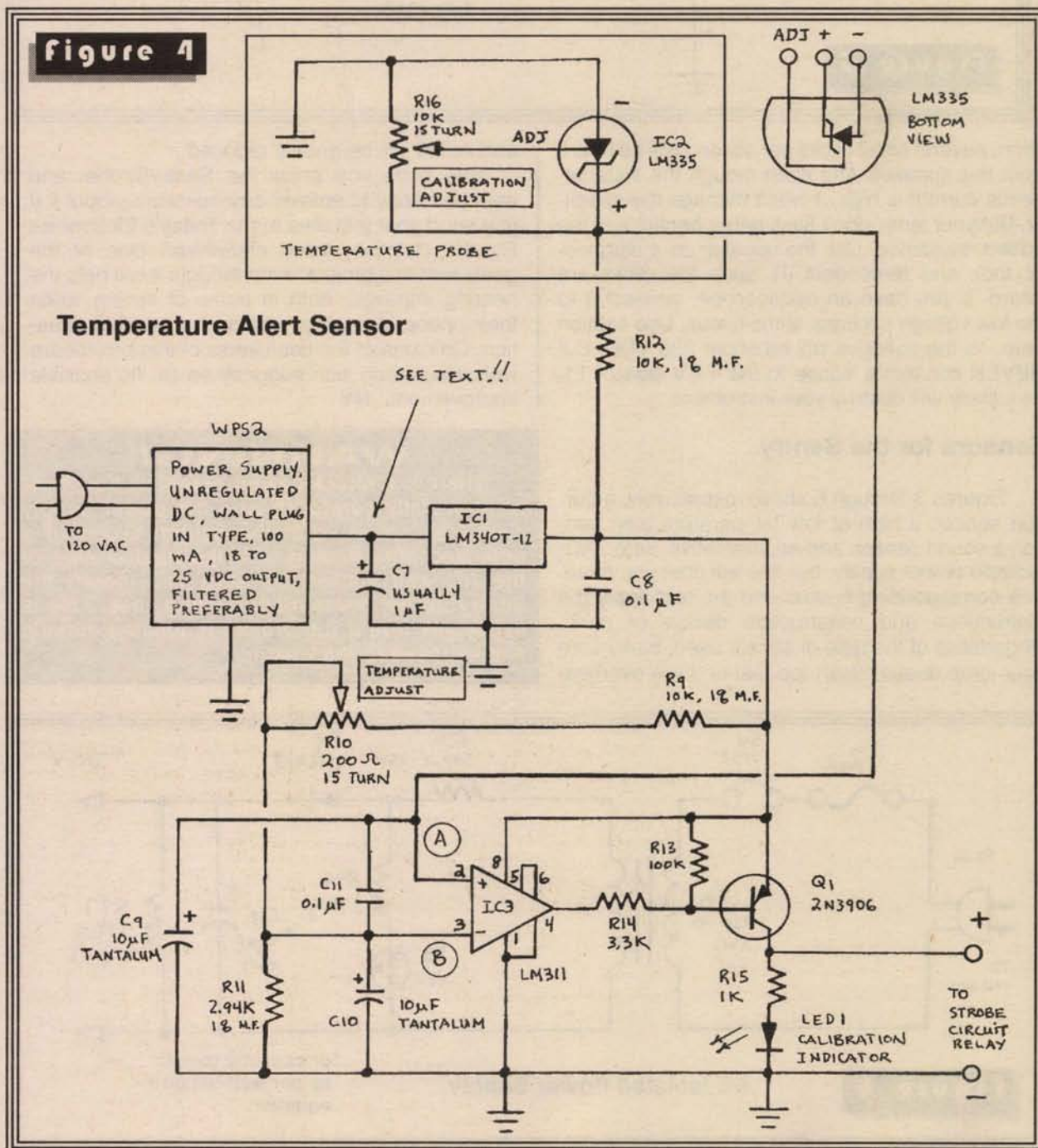


Figure 4

SOUND AND RINGER SENSOR

The sound and ringer sensor does just that, it detects audio. Telephones, crashes of kids playing where they shouldn't be, or unauthorized use of power equipment are typical of what this sensor can alert you to.

No connection to the phone line is needed, in case that's where this sensor will go. Locate the sensor element where you think its response will be best. Both rotary and touch tone types of phone ringers can be detected as long as their bells are not turned off. Figure 5 is the schematic for this sensor. Note the +12-volt power supply is REGULATED, or else this sensor won't work. An additional 100 uF filter capacitor, C12, is used to smooth voltage variations. Should the circuit prove tricky, increase C12's value to 470 uF, 1,000 uF, or even 2,200 uF — whatever value works the best.

Electret Microphone Sensor Is Sensitive!

Electret microphone MIC-1 picks up the sound, and amplifies it via an internal FET transistor. The microphone element requires several mA of bias supply, which is provided through R17. Output from MIC1 fed into IC4, an LM386 low-voltage audio power amplifier. IC4's voltage gain is fixed at 200 by virtue of its internal components and feedback capacitor C14. Capacitor C14 must be located close to IC4. A 680 pF ceramic disc bypass capacitor at IC4's input ensures IC4 will not amplify ultrasonic sounds, which we don't need with this circuit.

Capacitor C16 and resistor R18 form a snubber circuit that prevents RF or ultrasonic signals at IC4's output. C15 blocks DC output from this amplifier. The IC has an internally biased output at one-half its supply voltage, therefore amplified signals are outputted virtually undistorted by the IC, plus it requires only a few external components to achieve this effect. By the way, the LM386 is a great audio amp, please don't think its uses are limited to this circuit!

Negative swings of the amplified signal must be eliminated, however. How is this done? By adding a low-forward voltage Schottky diode, D3, and a series resistor, R19. That resistor's value is chosen to prevent overloading the amplifier's output, so we can sidetrack the negative voltage swing of the amp and feed just the positive voltage excursions to the integrating capacitor, C18, through a current-limiting resistor R22. The integrating capacitor stores a charge on it, and the greater the capacity of this part, the longer the charge will be stored, and hence the longer the strobe will flash after sensor activation. You must tailor the value of C18 for your application and audio specifics of same. However, the procedure involves just a small amount of trial-and-error.

Q2 buffers and amplifies the resultant signal so the relay in the strobe circuit is faithfully turned on. Bias resistors R21 and R23 adjust the transistor's operating level, so normally it's just barely on, but not enough to activate RLY1 until a valid signal appears from the sound sensor. R24 adjusts the transistor's output downward so that it won't mistakenly turn on RLY1 in absence of a valid signal. That signal is, of course, of significant value, and indicates an alert situation.

LED2 is the audio activation indicator, and it shows whether there is some audio activity that needs paying attention to. R20 limits the current to this part, and may be adjusted in value according to the LED used. This part may be increased in value if the relay doesn't activate faithfully, because there is the possibility, in this case, it's taking up too much of the desired signal.

SENSOR SUGGESTIONS

Carbon monoxide
Explosive gases like heating gas
Water level; either too high or too low
Hazardous fumes
Radiation sensing
Failure of critical systems; aquarium heater, refrigerator, etc.

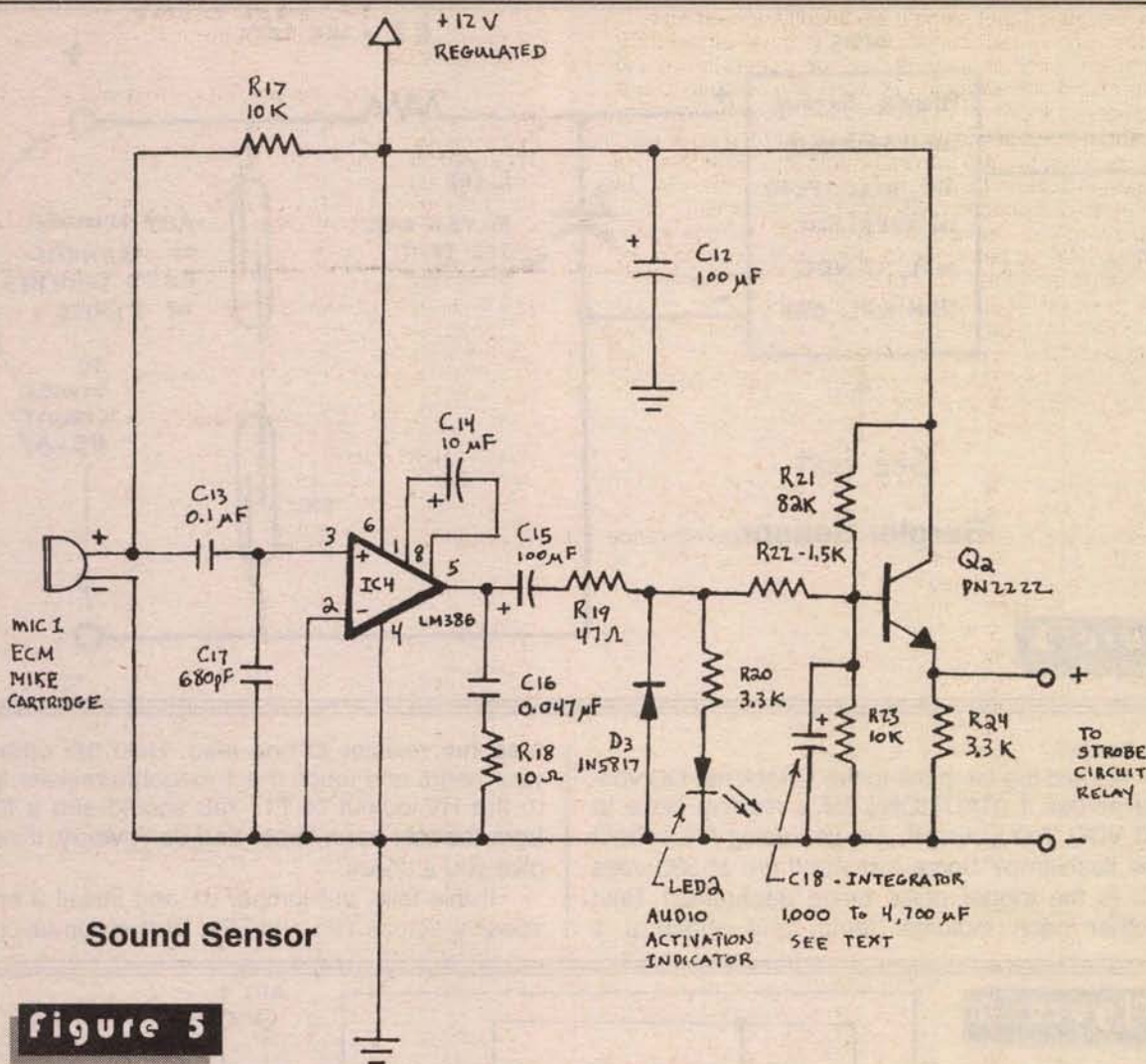


Figure 5

ation, several small clicks per second will be heard from this speaker. And even though the instantaneous current is high, it won't damage the speaker. But your lamp won't flash either because of the added resistance. Use the speaker as a diagnostic tool, and re-connect J1 once the clicks are heard. If you have an oscilloscope, connect it to the low voltage sections of the circuit. Use caution here, as the voltages will be about 330 VDC. But NEVER connect a 'scope to the 4 KV side of T1, as it likely will destroy your instrument.

Sensors for the Sentry

Figures 3 through 6 show, respectively, a burglar sensor, a high or low temperature alert sensor, a sound sensor, and an alternative, safer, AC-isolated power supply, but this will cost you more. The corresponding figures and the text apply the instructions and construction details of each. Regardless of the type of sensor used, make sure your lamp doesn't flash too fast or it will overheat

and its life will be greatly reduced.

We hope you enjoy the SentryStrobe, and we'll be happy to answer any questions about it if you send your inquiries to the Today's Electronics Reader Helpline, listed elsewhere. One of the goals with this project is the thought it will help the hearing impaired, both in terms of seeing when their phone is ringing, and during an alert situation. Opinions of the usefulness of this project are welcome, along with suggestions for its possible improvement. NV

WARNING!

There is a shock hazard potential. You must be especially careful to wire the power supply circuit as shown with the neutral prong of a polarized plug mating with the neutral side of the AC wall socket. Be sure you mount the SentryStrobe in a non-conducting case. This is especially true if the project is located outside and exposed to the weather!

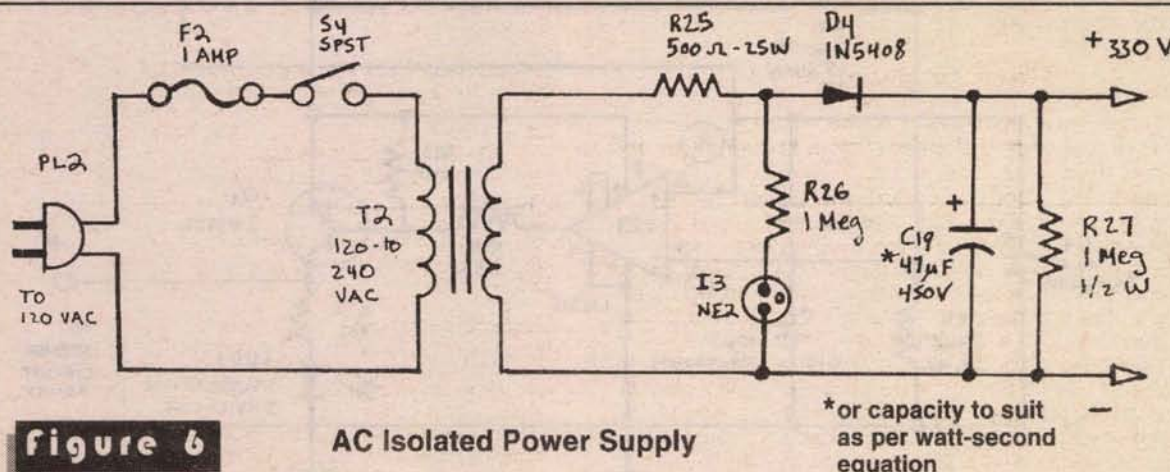


Figure 6

AC Isolated Power Supply

*or capacity to suit as per watt-second equation

"FAULTY FURNACE" LOW & HIGH TEMPERATURE SENSOR

In Figure 4, we note a precision, adjustable low temperature sensing circuit that can be modified to detect overtemperatures, too. Three inexpensive integrated circuits comprise this sensor. A 12-volt regulator, IC1, supplies both power and a voltage reference. It is important the output of the regulator be as close as possible to +12 volts within reason; $\pm 5\%$ will do. That can be obtained by checking several regulators with your DMM and choosing the one closest to the optimum 12 volt value.

Note C7 which is labelled "usually 1 μF ." This is the filtering capacitor which allows a stable output from IC1. It is critical to the operation of the circuit to be aware of the output of WPS2, the wall transformer DC supply, and whether it is regulated or well filtered. All one needs if regulated or well filtered is the 1 μF filter capacitor at IC1's input. However, if the output of WPS2 is unregulated and poorly filtered, you will have to increase the value of C7 to 1,000 μF . Choose the WVDC of C7 to allow an adequate safety margin over the maximum output voltage of WPS2.

An LM355 precision temperature sensor, IC2, is mounted in a homemade probe along with its companion trimming potentiometer R16. This potentiometer provides precise adjustment of a calibration voltage reference for IC2. It was chosen for multiple turns and a low temperature-drift coefficient (called tempco for short). IC2 must be in contact with the medium to be sensed. That medium may be air or water. Or a fluid or gas that is non-corrosive to the little TO-92 epoxy plastic transistor package which houses IC2. Should a probe be in contact with a liquid medium, you'll have to encapsulate R16 in a glue-like silicone RTV, which will protect it from contamination. Wires leading to the probe and the pinout end of the IC must be sealed too. R16 requires no re-adjustment after initial (albeit careful) calibration.

What's a Kelvin Temperature Proportional Voltage Output?

That's easily answered. IC2 has an output voltage that is proportional to temperature. Output is exactly 10 mV per degree Kelvin, referenced to absolute zero. IC2 is similar to a precision zener diode whose reverse breakdown voltage is temperature dependent. The Kelvin scale starts at absolute zero or -273.15 degrees Centigrade. Brrr ... Also, one degree K is equal exactly in quantity to one degree Centigrade. Kelvin's scale adjusts the freezing point of water (32 F or 0 C) at 273.15 K.

When immersed in freezing water, IC2's output will be 10 mV * 273.15 K. That figures to 2.7315 volts. R16 will calibrate this value, which is easy to achieve because everyone has access to ice and water, and the probe will be immersed in such for calibration.

IC3 is set up as a comparator, and its NEGATIVE input at (B) sees voltage from the adjustable divider consisting of R9, R10, and R11. All of the divider components are necessarily of the precision, low-tempco variety. The POSITIVE input at (A) sees the voltage from IC2. Normally, IC3's output will be Logic 1 or posi-

tive, because input signals electrically appear as a "warm" or "normal" condition. Q1, a small-signal PNP transistor, will then stay off. Voltage generated by the probe assembly dropping BELOW the setpoint of the comparator's divider network will activate the comparator and its output will go to Logic 0, turning on Q1.

In doing so, the transistor activates both the "calibration indication LED" and RLY1 of the SentryStrobe circuit. Note capacitors C9 and C10 are tantalum types who intrinsically have both low current leakage and low tempco. We added these to stabilize the operation of the circuit, and they are not expensive components. C11 prevents spurious oscillation of the circuit. It is a good idea to assemble the circuit on a small PC board; a Radio Shack experimenter board will be fine. Long lead lengths will result in possible failures due to nuisance oscillations developing.

Calibration

As shown, the voltage divider consisting of R9, R10, and R11 is adjustable from 2.72 V to 2.86 V. Translated to Fahrenheit, this means a response range of 30 F to 55 F. To calibrate this sensor, the following procedure is suggested:

- Buy or borrow an accurate thermometer. Use it in conjunction with your DMM. IC2 should be placed in a medium at exactly 25 C (77 F). Set R16 so the voltage at pin 2 of IC3 is 2.980 V.

- The temperature adjust potentiometer, R10, must be set to the low temperature chosen to trigger the SentryStrobe. So if the setpoint choice is 40 F, this equates to 4.4 C. Now add 273.15 to the Centigrade temperature to convert to the Kelvin scale. That is 277.6 K in this case. Multiply by .01 (voltage output per degree K) and one achieves 2.78 volts. Now adjust R10 to read 2.78 V at pin 3 of IC3. If the temperature of the sensing element falls below 40 F, the SentryStrobe will start flashing.

- Let's check your sensor's low-temperature accuracy next. Mix ice and water in a styrofoam cup. Set R10 for 32 F where it will trip at 2.74 V. Immersing the probe should cause LED1 to come on quickly, within half a minute. If LED1 does not come on, adjust R10 until it just does. Now you've calibrated the circuit at 32 F.

Modification Methods

The faulty furnace sensor may be modified to react to any temperature over its -10 C (14 F) to its +100 C (212 F) response range. To do so, vary the ratio of divider resistors R9 and R11, and change the temperature adjust potentiometer, R10's value to suit. This will alter the temperature response range of the sensor and its adjustment span according to the values you have chosen. Full data may be obtained for this IC from Digi-Key for a slight additional charge, and that will give you additional data to go on.

OVER-temperature conditions can be tracked as well. What's required is reversing the connections at pins 2 and 3 of IC3. The comparator will then trip if the temperature probe assembly encounters a sensed limit greater than the corresponding electrical value of the fixed voltage divider. One can imagine such applications such as warning of overtemperature in a greenhouse used for growing rare plants.

Should you notice an erratic operation of the circuit (once the main strobe circuit is correctly functioning), install a filter capacitor at C(x). It just may be DC voltage fluctuations are causing the problem, or the length of the sensor line. 220 μF to 1,000 μF is suggested; use an electrolytic capacitor that is rated twice the maximum DC voltage of the wall transformer's output, so it will be assured to last a long time under all environmental conditions.

Rats or Burglars?

I once had an experience where my brother and I installed a siren-based alarm system at every door and window which protected a shop full of valuable antiques. We found this system was malfunctioning quite frequently. Every time a problem occurred, the siren would let off an ear-piercing blast, often in the middle of the night which would wake up everybody in its proximity! It turned out we found two problems: one was a door gradually wore through a wire in the course of "people-traffic" in the shop. The other was a wire was unknowingly located near a rat-run, and they decided to gnaw through it periodically. So, the lesson here is to locate the wire correctly, and use a good gauge of wire. Heavy gauge speaker wire is a good idea; we were using a light gauge for aesthetic reasons, but that obviously let the rats have their own way.

Parts List

All resistors are 1/4 watt, 5% carbon composition unless otherwise noted

STROBE CIRCUIT — Figure 1

R1 — 1 megohm
R2 — 750,000 ohm
R3 — 470,000 ohm
R4 — 4.7 megohm
C1 — 0.1 μF , 250 WVDC polyester, #E2104-ND or similar
C2 — 0.047 μF , 250 WVDC polyester, #E2473-ND or similar
C3 — 0.047 μF , 400 WVDC polyester, #E4473-ND or similar
FL1 — Xenon flashlamp, U shaped, 45 Watt/seconds or to suit (these are available at Radio Shack and through sellers like Mouser and All Electronics)
T1 — 4 KV, trigger transformer, three-wire type
I1 — NE-2, neon indicator lamp
SCR1 — 4 A, 400 V, sensitive gate silicon controlled rectifier, #T106D1-ND
RLY1 — Reed relay, 5 to 12 volt, high resistance coil
L1 — Optional choke coil
S1 — SPST normally open pushbutton switch
J1 — Wire jumper, gauge not important
Misc. — Non-conducting enclosure, optional reflector for flashlamp

POWER SUPPLY — Figure 2

R5 — 1 megohm, 1/2 watt
R6 — 500 -ohm, 25 watt power resistor, #VP25K500-ND or equivalent
R7 — 470,000 ohm
D1, D2 — 1N4007, 1-A, 1,000 PIV rectifier
C4, C5 — 100 μF , 350 WVDC aluminum electrolytic
PL1 — Polarized (important!) plug & line cord
I2 — Neon indicator lamp
Misc. — Non-conducting enclosure

INTRUDER SENSOR — Figure 3

WPS1 — Wall-plug AC-to-DC power supply, 100 mA or more, 12 VDC nominal, unregulated
C(x) — Optional filter capacitor, see text
Misc. — Any number of magnetic reed switches

TEMPERATURE SENSOR — Figure 4

IC1 — #LM340T-12-ND, 12 volt positive voltage regulator
IC2 — #LM335Z-ND, precision temperature sensor
IC3 — #LM311N-ND, high performance voltage comparator
Q1 — 2N3906 PNP transistor
LED1 — LED to suit
R9, R12 — 10,000-ohm, 1% metal film
R10 — 200-ohm, 15-turn potentiometer, #3006P-201-ND or equivalent
R11 — 2,940-ohm, 1% metal film
R13 — 100,000-ohm
R14 — 3,300-ohm
R15 — 1,000-ohm
R16 — 10,000-ohm, 15-turn potentiometer, #3006P-103-ND or equivalent
C7 — 1 μF , 35 WVDC aluminum electrolytic
C8, C11 — 0.1 μF , ceramic disc capacitor
C9, C10 — 10 μF , 25 WVDC tantalum, #P2049 or similar
WPS2 — Wall-plug AC-to-DC power supply, 100 mA or so, 18 to 25 VDC output (nominal), filtered preferably
Misc. — IC sockets, homemade temperature probe consisting of IC2 and calibration pot, R16, to suit

SOUND SENSOR — Figure 5

IC4 — #LM386N-1-ND low voltage audio power amplifier
Q2 — PN2222 NPN transistor or similar
LED2 — LED to suit
MIC1 — Electret condenser microphone, unidirectional, #P9949-ND or equivalent
D3 — #1N5817CT-ND, 1-A, 20 PIV Schottky barrier rectifier
R17, R23 — 10,000-ohm
R18 — 10 ohm
R19 — 47 ohm
R20, R24 — 3,300 ohm
R21 — 82,000 ohm
R22 — 1,500 ohm
C12, C15 — 100 μF , 25 WVDC aluminum electrolytic
C13 — 0.1 μF , ceramic disc
C14 — 10 μF , 35 WVDC aluminum electrolytic
C16 — 0.047 μF , ceramic disc
C17 — 680 pF, ceramic disc
C18 — 1,000 μF to 4,700 μF , 25 WVDC aluminum electrolytic

AC ISOLATED POWER SUPPLY — Figure 6

T2 — 120-to-240 VAC step-up transformer
C19 — 47 μF , 450 WVDC aluminum electrolytic
D4 — #1N5408GICT-ND, 3-A, 1,000 PIV rectifier or similar
I3 — NE-2 neon indicator lamp
R26 — 500-ohm, 25 watt power resistor, #VP25K500-ND or equivalent
R27 — 1 megohm, 1/2 watt
F2 — 1-amp fast-blow fuse with holder
S4 — SPST switch
PL2 — AC line cord

Supplier notes:

Magnetic reed switches, LED's, plug-in transformers, 120-to-240 VAC step-up transformers, xenon flashlamps, HV electrolytic capacitors, and a wide variety of general electronic parts: All Electronics.

Parts prefixed with a pound sign (#) are specific Digi-Key stock numbers, who also carries the 1% metal film resistors and most of the other parts. Both suppliers are in the Supplier List.

INTRUDER SENSOR

An intruder intent on ripping off your home is certainly a major invasion of privacy, and a danger if you and your loved ones are in the house. You can disrupt his intentions by using the circuit shown in Figure 3. Reed switches, placed in series and wired around all critical areas, will activate the SentryStrobe if the circuit path is deliberately cut or if a protected door, window, or other entry point is displaced. SentryStrobe starts flashing right in the intruder's face when a magnetic reed switch is tripped by having its proximity magnet displaced! The blinding light frightens him quickly away, and alerts you and your neighbors.

This is the simplest sensor of the project. Normally Closed (NC) magnetic reed switch(es) are connected according to the diagram. You may use any amount of them in series. A small amount of power is run through the alarm system via the wall transformer. The voltage and current level of the transformer is not critical, however, the value and wattage of R8 is. It must be low enough in value to faithfully activate RLY1. Plus you want to ensure enough wattage of R8's value so that it won't burn out at a critical time! Wattage is determined by the equation $W = A * A * R$ where R is the resistor's value in ohms and A is the amperage it must conduct. Usually, a half watt resistor is enough. Digi-Key carries all values and wattages of resistors for you.

SUPPLIER LIST

Datak Corporation, 55 Freeport Blvd., Unit #23, Sparks, NV 89431; Ph: (702) 359-7474, FAX: (702) 359-7494. Dry transfers for PWB fabrication, chemicals, Circuit-Fix™ products. Free catalog.

Digi-Key Corporation, 701 Brooks Avenue South, P.O. Box 677, Thief River Falls, MN 56701-0677; Ph: (800) 344-4539, FAX: (218) 681-3380. Top-of-the-line supplier of SMT components; features a large selection. Free catalog.

Dyna-Art Designs, 3535 Stillmeadow Lane, Lancaster, CA 93536-6624; Ph: (805) 943-4746. Provider of and seller (through distributors as well) of the toner transfer system (TTS) method of PCB fabrication. Also sells a desk-top integrated package for small OEM and prototype PCB fabrication.

Electronic Goldmine, P.O. Box 5408, Scottsdale, AZ 85261; Ph: (602) 451-7454, FAX: (602) 451-9495. SMT surplus PWBs and SMT components. Some great values here. Free catalog.

ESP Solder Plus, 14 Blackstone Valley Place, Lincoln, RI 02865-1145; Ph: (401) 333-3800, FAX: (401) 333-4954. Small manufacturer, educational and industry SMT repair kits and solder cream.

Garrett Electronics Corporation, 3070 Skyway Drive #104, Santa Maria, CA 93455; Ph: (805) 922-0594, FAX: (805) 922-3643. Small and bulk quantities of surface mountable components. Low order minimum.

Hobby Lobby International, Inc., 5614 Franklin Pike Circle, Brentwood, TN 37027; Ph: (615) 373-1444, FAX: (615) 377-6948. Supplier of all kinds of hobby kits and supplies; mentioned here because of their large selection of instant-set-

ting glues and some tools that are useful to any precision endeavor such as with electronics. Catalog \$2.50.

Maxim Integrated Products, Inc., 120 San Gabriel Drive, Sunnyvale, CA 94086; Ph: (408) 737-7600, FAX: (408) 737-7194. Specialty analog and digital integrated circuits of amazing diversity and use. Call for nearest distributor or sales rep (in the case of OEMs). Will give out free info and samples to qualified companies.

Micro-Mark, 340 Snyder Avenue, Code 340-1892, Berkeley Heights, NJ 07922-1595; Ph: (800) 225-1066, FAX: (908) 665-9383. This company calls itself "The Small Tool Specialists" and indeed they are. Listed here because of the many precision hand and power tools they offer that are useful in SMT and other electronic work. Also carries hard-to-find supplies for model making. Full-color catalog \$1.00.

Pace Inc., 9893 Brewers Court, Laurel, MD 20723-1990; Ph: (301) 490-9860, FAX: (301) 498-3252. Manufacturer of SMT soldering/desoldering equipment and workstations.

PRB Line, P.O. Box 176, Whitewater, WI 53190; Ph: (800) 533-9654, FAX: (800) 635-8101. Carries an inexpensive SMC removal kit called ChipQuik.

Techni-Tool, 5 Apollo Road, P.O. Box 368, Plymouth Meeting, PA 19462; Ph: (215) 941-2400, FAX: (215) 828-5623. Soldering/desoldering equipment and electronic tools of all types.

All Electronics Corporation, P.O. Box 567, Van Nuys, CA 91408-0567; Ph: (800) 826-5432, FAX: (818) 781-2653. Some SMT parts and occasional surplus SMT boards useful for parts salvage and experimentation, plus a wide variety of surplus and new electronic parts. Free catalog.

Allegro Electronic Systems, 3 Mine Mountain Road, Cornwall Bridge, CT 06754; Ph. & FAX: (860) 672-4391. Wholesale broker, R & D lab, and small manufacturer supplier. Also sells to experimenters. Carries xenon flashlamps, miniature high voltage inverting transformers, various gas sensors like explosive, humidity, fluorocarbon, and toxic; has several inexpensive laser communication kits, supporting lasers, and stocks some quality HV surplus items. Free catalog bulletins. No minimum order.

Capital Advanced Technologies Inc., 309-A Village Drive, Carol Stream, IL 60188; Ph: (708) 690-1696, FAX: (708) 690-2498. Manufacturer of the Surfboard™ breadboarding medium for SMT, sells mostly through distributors such as Digi-Key. OEMs can contact Capital directly for large quantity pricing.

Carolina Biological Supply Company, 2700 York Road, Burlington, NC 27215; Ph: (919) 584-0381, FAX: (503) 656-4208. Laboratory supplies including test tubes, plastic, and glass vials handy for use categorizing SMCs. Contact for current price of their 30,000 item, full-color catalog.

Circuit Board Express, 2 Avco Road, Haverhill, MA 01835. Ph: (508) 521-9288, FAX: (508) 521-9388, Modem: (508) 373-9272, E-Mail: fastpwb@tiac.net — Time crucial manufacturer for industry. Produces prototype circuit boards in 24 to 48 hours. Not a hobbyist supplier.

Contact East, 335 Willow Street, North Andover, MA 01845-5995; Ph: (508) 682-2000, FAX: (508) 688-7829. SMT and electronic repair tools; chemicals. Free catalog.

Be sure to mention Nuts & Volts when you contact the above suppliers so they can process your requests properly.

Electronic Reading Resources

In the March installment of Today's Electronics, we mentioned readers who have written us asking how to get started in electronics. Somehow, a box listing reading resources dematerialized and didn't get into print. (Oops.) So, here's that listing for you now:

ARRL Handbook. This is the bible for many electronic aficionados. Published by the Amateur Radio Relay League, it is geared primarily toward amateur radio. However, it contains complete electronic theory, and explanations of the workings of electronic components from antennas to zener diodes, and everything in between. Lots of handy tables in here. Also contains projects to build that include test equipment, power supplies, and different RF amplifiers and receivers. Has about 1,000 pages; an exact count can't be made because of the chapter numbering system. Available from: ARRL, 225 Main Street, Newington, CT 06111. Priced at about \$25.00.

McGraw-Hill, Inc., Blue Ridge Summit, PA 17214-9988. Publisher of hundreds of diverse electronic books, McGraw-Hill is the best source for titles ranging from introductory to advanced. Also carries many math, science, computer, and aviation titles.

National Semiconductor. National's databooks feature lots of real-world circuit schematics and that's why they are recommended here even though they are not in the "beginner" class. I particularly find their *Linear Applications Handbook* to be very fascinating and full of practical application notes. Available at the larger mail order electronics houses like Digi-Key.

Radio Shack's Engineer's Mini-Notebooks. These are highly recommended for the beginner to electronics and the hobbyist alike. Written by Forrest Mims, one of America's most popular science writers, each book covers different topics such as: basic semiconductor circuits, communications projects, digital logic circuits, and so on. Of particular interest is *Getting Started In Electronics*, which currently is under \$3.00. Available at your local Radio Shack.

Texas Instruments. TI puts out a series of databooks describing the function of its massive line of integrated circuits. Again, while not "beginner electronics" type of references, they are valuable for the study of parameters, timing diagrams, and the like. Available at larger mail order electronics houses. The linear circuits 1-3 are of particular interest.

Educational System Survey

When I was in school, the availability of electronics and science education at that time was limited, but that was about 20 years ago. Today, we all are in a situation where technology has exploded, but choosing what's interesting and available and then bringing it to the hobbyist, experimenter, and professional level is what counts!

To the point: Educators, we would appreciate your input! Are you teaching or have you taught a class(es) that used ideas from these articles? We'd love to hear from you AND your stu-

dents. One suggestion for a class exercise would be to have the students take a few minutes to describe their project experiences (good and otherwise) on a postcard and mail it to the Today's Electronics Reader Helpline. This way, we'll find out what you want, and modify upcoming articles so they are best geared for today's student. Plus, the postcard idea may help the less than enthusiastic student get sparked by getting in touch with an external entity besides the teacher, which they get used to.

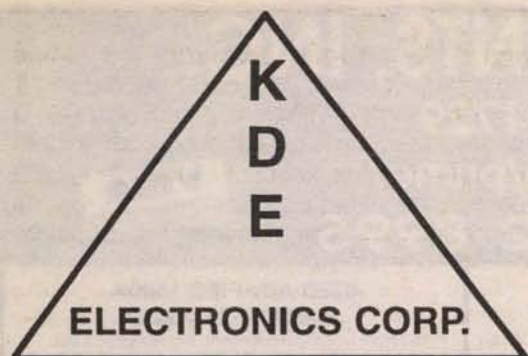
I'll do my best to drop a return line to as many people as I can. Thank you in advance!

Today's Electronics Reader Helpline

Today's Electronics is a Reader Interactive forum. We appreciate your interest, and would like to hear your comments, questions, and suggestions for future articles. Address your letters to: Today's Electronics, Attn: Anthony Charlton, P.O. Box 74, Cornwall Bridge, CT 06754. Your FAX number, which will be kept confidential, will greatly speed replies.

- Pete Haas is interested in obtaining more information about constant-current Ni-Cd battery charging circuits. His applications include sizes from AAA to D cells. While we have done a Ni-Cd battery charger circuit (see Dec. '95 *Nuts & Volts*) perhaps a simpler circuit would be more expedient. Any suggestions or information about good circuits would be appreciated, and we'll forward any data to Mr. Haas.

- Have you received your free (and hard-to-find) 22 megohm and 0.1 ohm resistors offered in a prior article? There were a few requests that got stuck in the wrong file (oh, for a full-time secretary; any volunteers?). We still have several hundred resistors left. If we missed you, re-submit your request, or if this is the first time you heard about it, we'll give you some too!



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80387SX-25	\$17.95	8749	\$5.95
80387DX-20	\$17.95	8749H	\$6.50
80387DX-25	\$24.95	8751	\$8.95
80486SX-25 (PGA)	\$14.95	8751H	\$9.95
AM486DX-33 (PGA)	\$17.95	8752	\$13.95
80486DX-50 (PGA)	\$19.95	8755	\$6.95

All parts, all socket pulls (must be cleaned & ESDed). *Note: Speed selection available at additional charge and all parts subject to availability.

EPROMS

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2764A	\$0.95	27C100	\$4.95
27C64	\$1.25	27C1001	\$6.50
27128	\$1.45	27C1024	\$3.95
27128A	\$1.45	27C020	\$5.95
27256	\$1.90		

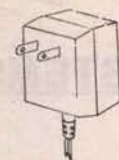
All DRAMS are clean socket pulls and have full leads.
4164-15.....\$0.18 Ea. 41256-15.....\$1.00 Ea.
4164-12.....\$0.25 Ea. 41256-12.....\$1.25 Ea.
41256-10.....\$1.35 Ea.

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The old-style type, but old reliable. Note: No software included with mouse.
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9Vdc 500Ma	\$2.95 Ea.
9.5Vdc 750Ma	\$3.50 Ea.
12Vdc 100Ma	\$1.25 Ea.
12Vdc 200Ma	\$1.50 Ea.
12Vdc 500Ma	\$2.95 Ea.
12Vdc 600Ma	\$3.95 Ea.
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NEW MOTOROLA FASTALK II 14.4 FAX/MODEM

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TEST EQUIPMENT cont.

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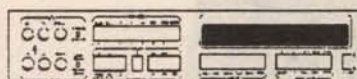
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TEKTRONIX 465M, 100MHz \$400; Tektronix 465, 100MHz \$375; Tektronix BDM1250 digital tester \$250; BK precision 1251, NTSC generator \$325; Wavetek 186 5MHz phase lock generator \$225. Might trade some equipment for Tektronix 2211 or might consider Class IV laser (working). Marc, 704-784-3649.



6 1/2 DIGIT DMM, mfg. in 80s by Datron. \$800-\$1,100. 818-503-2367.

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PACE DESOLDERING stations. SX-213A systems \$225. PCF-151 desolder/solder/rework stations \$495. Hi-Test Electronics, 303-417-9395.

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HP 8616A SIGNAL GENERATOR 1.8 to 4.5GHz, +10 to -127dBm RF output, ext. AM/FM/pulse modulation. \$250. HP 86240B sweeper plug-in \$500. 415-244-9254.

HP 6177C current source 0-50V, 0-500mA. \$255. Dexis 612-944-7670.

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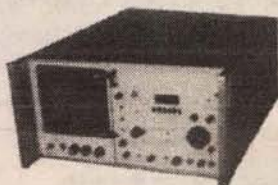
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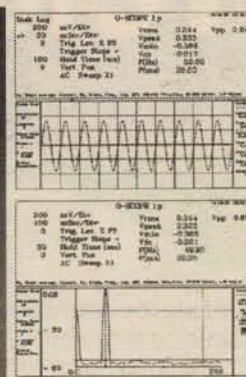
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Tele-Videoconferencing

Tele-videoconferencing is the ability to link two or more computer systems together to transmit real-time video pictures and sound to and from one or more computers.

Software kits are available for linking two computers together for videoconferencing over standard telephone lines for less than \$100.00. Individual software packages for single computers are \$55.00.

To American businesses, videoconferencing is a tool that provides an inexpensive way to hold meetings with executives around the world at a fraction of the cost it would be to fly everyone to a central location.

Videoconferencing is also used for new product demonstration to a company's sales force.

Medicine has found many uses, so much so that a new science of tele-medicine is being born. Some uses are the ability for doctors to conference with other doctors and specialists around the world. They can transmit pictures of x-rays, MRIs, EEGs, and EKG traces along with real-time sound of a person's heartbeat. This is a boon to third world countries where doctors and medical personnel are in short supply, and a trip to a medical facility may be hours away.

However, when the average computer user thinks of computer videoconferencing, they see mainstream corporate America with the money and high technology behind it making it work. While videoconferencing works quite well on LANs (Local Area Networks), WANs (Wide Area Networks), and high-speed ISDN telephone lines, it is possible to use standard telephone lines. What makes this tele-videoconferencing possible for the average user is the proliferation of high-power home computers, like the Pentium and 486 PCs. This, coupled with the development of inexpensive PC

software, creates real-time computerized tele-videoconference systems over standard telephone lines.

Video Phone

Videoconferencing technology is under continuous development to bring real video phones into the home. This is a multi-billion dollar market. It promises to keep research and development in this area active. Fortunately for computer users, most advances will be seen in the computer software long before it filters down into consumer electronics.

tations described for this software will not be true for videoconferencing systems that operate over LANs, WANs, and ISDN telephone lines.

The other tele-videoconferencing software that operates over computer LANs, WANs, and dedicated ISDN telephone lines have better picture quality and frame rates. The reason being that the dedicated communication lines between the computers can handle faster data rates, but they are of no use over standard telephone lines.

It's easy to believe that the term "Live or Real-Time Video" means home video quality and speed. Not

and video compression/decompression. There are two emerging technologies that can really boost video transmission over the phone lines: fractal and wavelet compression. Both of these mathematical techniques are too complex to discuss here, but they do represent a quantum leap in codecs (compression and decompression) technology.

Video Capture Card

To transmit video from your computer, it must be equipped with a video capture card and video source (camera, VCR, etc.). However, to receive video from another computer doesn't require any special hardware. The software is compatible with most capture cards that operate under Windows.

Because most of the telephone line's bandwidth is used to transmit video pictures, talking on the same telephone line is not possible. Instead, to communicate with the other computer, the software incorporates a two-way dialog box. Users can type messages in the dialog box to each other. It's not as good as talking, but it works.

Cost Evaluation

Aside from the operating cost of the computer and software package, the cost is equal to the phone call.



At its present state of development, you still need the power of a 486-33 MHz computer system running Windows 3.1 or Windows 95 with a minimum 14,400 baud modem to achieve two-way tele-videoconferencing. This support system is just a little too expensive to package with your standard telephone just yet.

How Good is the Technology

For the rest of this article, I will cover the inexpensive PC software package. The parameters and limi-

yet, I'm afraid. The video is live, but averages only about two frames per second. This falls pretty short of commercial film, video, and television that averages 24-30 frames a second.

Even at the slow speed of two frames per second, the video picture does not fill the entire computer screen. On average, the video box size is between 25% to 33% of the computer's full screen.

Fortunately, the picture quality of the incoming video is good. The frames-per-second rate will continue to improve as better algorithms are developed for high-speed modems

POTS Videoconferencing

POTS is an acronym that stands for Plain Old Telephone System. The reason why POTS tele-videoconferencing software is so important is that it allows computers to send and receive video pictures over standard telephone lines.

The disadvantage of POTS is that the old telephone line system has limited bandwidth that was never designed to work with high-speed digital circuits. Even so, remarkable advances have been made in developing high-speed modems (28,800 baud +) and video

software. Most development takes the form of improved codecs algorithms (software). As the technology advances, larger pictures with faster frame rates will become available.

Modems

To transmit and receive the live video requires at least a 14,400 baud modem. Naturally, a 28,800 baud modem will work much better.

Begin the program by first running the "settings" program. This opens a dialog screen that you fill in information about your system, like what speed is the modem you are using and what COM port the modem is connected to. Click on the "OK" button when finished. Start the main program.

Receiving a Call

At the top of the screen toward the middle, there is a small red box with the message "Waiting For Call." When a call comes in, a dialog box opens in the middle of the screen stating, "There is a modem call," "Accept?" Click on the "Yes" box and you're off and running.

A video dialog box opens in the lower right-hand corner of the screen. Move the dialog box over and open it up using the slider on the bottom of the box. You should be able to open the video box till it covers 25 to 33 percent of your computer screen. When you first open the screen, the picture may appear grainy or pixelated; this will clear up in a few seconds. If the picture doesn't clear up, the video box is too big, you must make it smaller to get a high-quality picture. Move the slider down using the mouse.

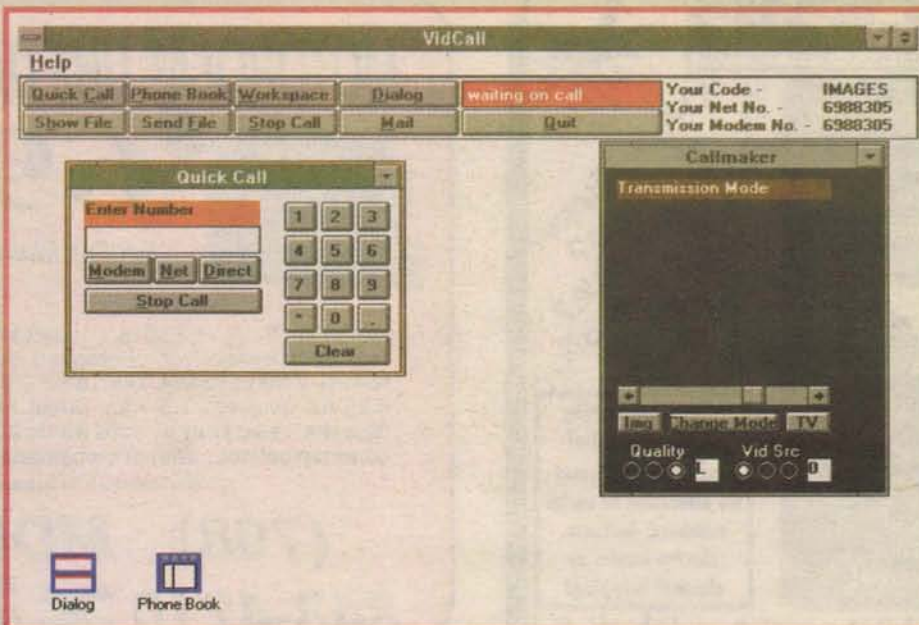
You may be able to open the video box larger, or be forced to make it smaller depending upon the modem speed and telephone line quality; see paragraph on "Optimizing the System" for optimizing system settings to peak the performance of the software.

Dialog, Dialog

If the dialog box didn't open up immediately when you connected to the service, double click its icon lying in the lower left of the computer screen with the mouse. The top portion of the dialog box is titled "Sending." Here is where you type your messages and requests to the model. The bottom portion of the dialog box is titled "Receiving." This is where you will see the model's typed response.

Making a Call

Vidcall has two dialog boxes you may use to initiate a call: "Quickcall" and "Phonebook." The phonebook stores your commonly



used phone numbers for easy access. For this example, we will use "Quickcall." Double click on the "Quickcall" icon. This action opens the dialog box. Enter the number you want to call including the area code and hit the modem button. The modem dials the number and makes the connection to the other computer. When the other computer accepts the call, the video box becomes active. Vidcall also opens up a "Callmaker" video window that shows the video picture you are transmitting. Typically, I close this box to keep my screen uncluttered.

Optimizing the System

By optimizing the system, we can make the videoconferencing system faster and more robust. Here are a few changes you can make.

First, create a RAM drive. The RAM drive sets aside an amount of memory to be used for files and buffers for incoming data. To configure a RAM drive, add the following line to your config.sys file.

```
Device=C:\dos\ramdrive.sys 512 /e
```

This line creates a 512K (1/2 meg) RAM drive. Reset the computer so it will initialize with the RAM drive. Go to the settings program of the video receive program and enter the single letter which represents the RAM drive (typically d:).

If the RAM drive takes up too much memory to operate Windows or the program, you can reduce the size of the RAM drive from 512 to 256 or 128 by just changing the number in the config.sys line. Remember to reset the computer after you make any changes to initialize those changes.

When you are not using the tele-video service, you can place REM in front of the RAM drive line in config.sys to effectively remove it from operating without erasing the line. Remember to reset the computer after you make this change to initialize the new config.sys file

and remove the RAM drive from memory.

```
REM Device=C:\dos\ramdrive.sys 512 /e
```

When you want to use the videoconferencing software again, remove the REM from in front of the line, reset the computer, and you are ready to go.

The second change that improves the speed and quality has to do with the VGA or SVGA card in your computer. Many cards operate at the 256 color mark. However, if your card has a 32,000 color driver, install it into Windows and select it.

Once this is accomplished, you must go back to the settings program and change the 256 color to 32K color.

Internet Access

The latest version of Vidcall has Internet access. By using a compatible service provider, you will be able to transmit and receive video over the Internet. It is also possible to transmit and receive sound over the Internet, if you have a compatible sound card in your computer. When using the sound feature, video is halted and resumes once the sound option is terminated. NV

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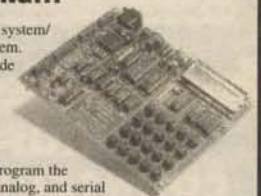
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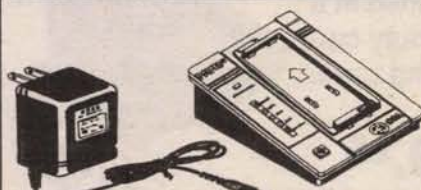
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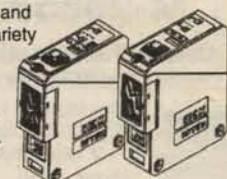
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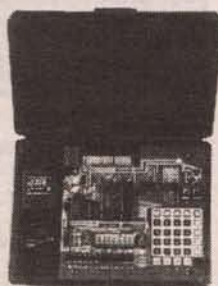
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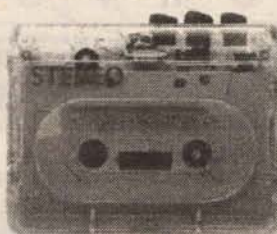


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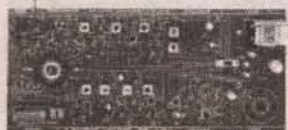
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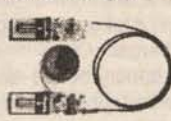


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Fuke 8921A/03, True RMS Voltmeter	\$600	Polarad 1207, Signal Source 3.8-8.2GHz	\$200
Fuke 9010A, Micro-System Troubleshooter Opt. 001	\$450	Polarad 640-1, Spect. Anyz., .003-18GHz Dig. Storage	\$1,200
Fuke A90, Current Shunt	\$200	Polarad SPNH, Generator 20Hz 20KHz	\$450
Fuke Y800B, Touch Hold Probe	\$40	Power Designs TW5005D, Dual Output, 0-50V	\$100
FW Bell 620, Gaussmeter, with Probe	\$250	Powerlec 6D6000, Power Supply, 6 Outputs	\$200
General Radio 1482Q, Standard Inductor, 2 Henry	\$200	PPM R5, Resistor Standard, 1-111.1K, 1 Ohm Res	\$150
General Radio 1538A, Stroboscopic, Strobe Scope	\$400	Racal Dana 9035/11A, Computer Counter, Opt. 01/06/55, Unused	\$300
General Radio 1538-P4, High Intensity Flash Capacitor	\$100	Racal Dana 9303, True RMS RF Level Meter	\$800
General Radio 1650A, Impedance Bridge	\$200	Racal Dana 9515, Universal Counter, HPIB, Opt. 41	\$200
Glow-Mac 20-500, Portable Inertness Analyzer, Unused	\$250	Schlumberger 7061, Systems Voltmeter, 7.5 Digits	\$700
Guideline 9152/P4, Standard Cell, Double Oven	\$300	Schlumberger SI-1253, Gain Phase Meter	\$1,000
Halcyon 520B3, Universal Test System	\$300	Sencore TF30, Super Cricket Transistor Tester	\$200
Hameg HM 208, Digital Storage Scope, Unused	\$600	Syston Donner 6243A, Counter 1.2GHz, 1Hz Res	\$200
Hiptronics HDA101, Hipot Tester 0-10KV	\$300	T.B.E. 208, C, L Meter, 11F-10uF, 1nH-10H	\$300
HP 105A, Quartz Frequency Standard	\$600	Tek 11302, Scope, Programmable, 500MHz	\$2,000
HP 11049A, Thermal Converter, 3 Volts	\$100	Tek 1502/04, TDR Cable Tester, with Chart Recorder	\$1,495
HP 1120A, Active FET Probe Kit, 500MHz	\$150	Tek 1503, TDR Cable Tester 0-50,000 Ft.	\$1,295
HP 1124A, 100MHz Active Divider Probe, Unused	\$100	Tek 178, Linear IC Test Fixture, For 577	\$300
HP 11710B, Down Converter, Frequency Standard	\$200	Tek 284, Pulse Generator	\$350
HP 11971K, Waveguide Mixer, 18-26MHz	\$800	Tek 4041, Systems Controller for GPIB	\$200
HP 1200A, Scope, Dual Trace .1mV-20V	\$100	Tek 464, Scope/100MHz Dual Trace, Storage	\$500
HP 1415A, Time Domain Reflectometer Plug-in, 141T	\$200	Tek 465M, Scope, 100MHz, Dual Trace, Delayed Sw.	\$400
HP 1725A/034, Scope, 275MHz Dual Trace, w/DMM	\$600	Tek 466, Scope, 100MHz Dual Trace, Storage	\$600
HP 1815A/1816A, TDR/Sampler, DC-4GHz	\$400	Tek 466/DMM4, Scope, 100MHz, Storage, DMM	\$650
HP 2804A, Quartz Thermometer	\$300	Tek 475, Scope, 200MHz, Dual Trace	\$600
HP 3300A, Function Gen. with 3302A Phase Lock	\$150	Tek 492, Spectrum Anyz. 50KHz-21GHz Opt. 1, 2, 3	\$6,000
HP 3310B, Function Gen. 0-5MHz PUL, RAM, SQ, TRI	\$250	Tek 577/177, Transistor Curve Tracer	\$1,000
HP 3320A, Frequency Synthesizer	\$250	Tek 624, XY Monitor	\$200
HP 3320B, Frequency Synthesizer	\$350	Tek 7403N, Scope Mainframe, Rack Mount	\$200
HP 3325A, Synthesized Function Generator	\$2,000	Tek 7A29, 1GHz Vert. Amp, 7000 Series Mainframe	\$450
HP 3330B, Automatic Synthesizer	\$400	Tek 7A29/04, 1GHz Vert. Amp Variable Delay	\$500
HP 3400A, RMS Voltmeter 1mV-300V, 10Hz-10MHz	\$150	Tek 7B85, 400MHz Delaying Time Base	\$150
HP 3455A, High Accuracy Voltmeter 6.5 Digit	\$400	Tek 7CTIN, Curve Tracer Plug-in	\$350
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HP 3457A, 6.5-7.5 Digit Multimeter, LCD Display	\$2,000	Tek 7L18/7603, Spectrum Anyz. 1.5-18GHz	\$3,000
HP 3570A, Network Analyzer	\$500	Tek 7S12, TDR/Sampler	\$400
HP 3575A, Phase Gain Meter, Opt. 01, Dual Displays	\$600	Tek AM503, Current Probe Amp	\$400
HP 3580A, Spectrum Anyz., 5Hz-50KHz, 1Hz Res	\$1,000	Tek DC503, Universal Counter Timer TM500	\$150
HP 3581C, Selective Level Meter	\$600	Tek DC503A, Universal Counter, 125MHz TM500	\$200
HP 3586C, Selective Level Meter, 50 Ohm	\$1,000	Tek DC504, Counter/Timer TM500	\$100
HP 394A, Attenuator, 1-2GHz, 200 Watts	\$125	Tek DM502, Multimeter TM500 Modular System	\$100
HP 4270A, Automatic Capacitance Bridge	\$800	Tek FG501, Function Generator	\$200
HP 432A/478A, Power Mtr., Cable, Mount, 10MHz/10GHz	\$300	Tek LA501W/WR501, Logic Analyzer	\$150
HP 435A/4841A, Power Mtr., Cable, Sensor, 10MHz/18GHz	\$800	Tek P6016, Current Probe with Termination	\$150
HP 4800A, Vector Impedance Meter	\$600	Tek P6045, FET Active Probe	\$100
HP 4815A, Vector Impedance Meter	\$900	Tek P6201, FET Probe Kit, 900MHz	\$350
HP 5004A, Signature Analyzer	\$100	Tek P6202A, FET Probe Kit, 500MHz, Unused	\$400
HP 5005B, Programmable Signature Multimeter	\$400	Tek P6452, Data Acquisition Probe	\$100
HP 5300B, 5308A, 75MHz Timer Counter	\$200	Tek P6464, Pattern Generator Probe	\$50
HP 5328A, Universal Counter, 500MHz, HPIB	\$350	Tek P6465, Pattern Generator Probe, New in Box	\$150
HP 5334A, 100MHz Universal Counter, HPIB	\$1,400	Tek PS501-1, Power Supply 0-20V, TM500	\$150
HP 5340A, Frequency Counter, 18GHz	\$1,000	Tek PS503A, Dual Tracking Power Supply, TM500	\$200
HP 5340A, Frequency Counter, 18GHz, LED, HPIB	\$1,200	Tek S3, Sampling Head	\$100
HP 54200A, Digital Storage Scope, Dual Trace, 200MG/S	\$1,000	Tek S5, Sampling Head	\$100
HP 54201D, Digitizing Scope, 300MHz	\$1,800	Tek S53, Trigger Recognizer Head	\$350
HP 6177C, DC Current Source 0-50V, 0-500mA	\$300	Tek SG502, Sig. Gen. 5Hz-50KHz TM500 Sys.	\$200
HP 7015B, XY Recorder	\$200	Tek SG503, Sig. Gen. 250KHz-250MHz	\$600
HP 745A, AC Calibrator .1mV-110V 10Hz-110KHz	\$350	Tek TM503, Mainframe 3 Slot, TM500	\$100
HP 779D, Directional Coupler, 1.7-12.4 GHz	\$200	Tek TR502, Tracking Gen., 1-1800MHz for 7L12, 7L13	\$1,000
HP 8018A, Serial Data Generator	\$300	Tek TR503, Tracking Gen. 1-1800MHz for 492, 4, 6	\$1,000
HP 8165A, Programmable Signal Source, .0001-50MHz	\$2,000	Tek WM4902, Waveguide Mixer Set, 18-40GHz, 492	\$1,000
HP 8410B, Network Analyzer	\$200	Vu-Data 5110, Semiconductor Tester, In/out Circuit	\$250
HP 8412A, Phase Magnitude Display	\$200	Wavetek 1002, Sweep/Sig. Gen. 0-500MHz	
HP 8443A, Tracking Gen., 100K-110MHz LED Display	\$400	Wavetek 114, Sweep/Trigger VCG	\$350
HP 8444A, Tracking Generator	\$800	Wavetek 144, HF Sweep Gen. .0005Hz/10MHz	\$200
HP 8444A/059, Tracking Generator	\$1,200	Wavetek 145, 20MHz Pulse/Function Generator	\$300
HP 8445B, Spectrum Anyz., Automatic Pre-Selector	\$400	Wavetek 154, Programmable Waveform Gen. .001Hz-10MHz	
HP 8481A, Power Sensor, with Cal. Sheet	\$400	Wavetek 2002A, Signal Gen. Sweeper, 1-2500MHz	\$1,600
HP 8553B, Spectrum Anyz., RF Plug-in, 1K-110MHz	\$200	Wavetek 3001, Signal Gen. 1-520MHz, AM, FM	\$800
HP 8553B/8552B, Spect. Anyz. 141T System, 1K-110MHz	\$1,000	Wavetek 859, Programmable Waveform Gen.	\$1,000
		Wavetek 907, 7-11GHz Signal Generator	\$650

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Stamp Applications:

Putting the Spotlight on BASIC Stamp Projects, Hints, and Tips

by Scott Edwards

Two BS2-related topics keep coming up lately: how to use the RTime instruction, and how to store and manipulate text strings. So this month I'll explain the electronic underpinnings of RTime, show a couple of methods of storing and retrieving EEPROM strings, and continue the BASIC-for-beginners series with systems of numbers.

Understanding the RTime Instruction and Creating Strings in EEPROM BS2 Programming Hints

RTime

It's great that the Stamps have attracted so much interest from people with little background in electronics or programming. And it's remarkable how much non-techies can accomplish by following recipes like the ones I present here.

But sometimes I think that these folks are shortchanging themselves by failing to learn the fundamentals. A case-in-point is the widespread misunderstanding of the new RTime instruction — most everything you could want to know about RTime is taught in the first five weeks of Electronics 101.

To prove it, I hauled my old textbook and applied it to RTime with gratifying results.

Let me start with a little background: RTime is the BS2's counterpart to the BS1's Pot instruction. The purpose of both instructions is to measure a resistance by seeing how long it takes to charge or discharge a capacitor through that resistance. That's where the similarity ends.

Pot takes an active approach to this measurement. It charges the cap to +5V, then enters a loop, discharging the cap a little at a time with each loop. It does this by placing the pin into an output-low state briefly, then back into input mode to see whether the capacitor is still charged.

Pot counts the number of loops required for the charge on the capacitor to change from 1 (> 1.5V) to 0 (< 1.5V).

Pot's loop count can run as high as 65,535 (max value of a 16-bit number), but is scaled to fit within an 8-bit variable (0 to 255) using a factor supplied by your program. The BS1 host program STAMP.EXE includes a routine for determining this scale factor, in essence calibrating the Pot command for variations in capacitor value and resistance range.

Figure 1 shows a standard connection for the Pot instruction, while Figure 2 is a storage-oscilloscope record of Pot in action. The downward spikes along the discharge curve are the brief output-low states of the Pot pin.

RTime works in a different way, inside and out. Figure 3 shows a typical hook-up. RTime relies on your program to set the capacitor's initial state; in the case of Figure 3, you would briefly output a high on the RTime pin. It's confusing, but this would discharge the capacitor by placing both of its leads at the same potential, +5V.

When the RTime instruction executes, it puts the specified pin into input mode and merely waits for the capacitor to charge through the pot or unknown resistance. This charging action is seen as the voltage at the lower, I/O-pin end of the cap getting closer to ground. All the while, RTime is counting up at 2-microsecond (μs) intervals. When the voltage at the lower pin of the cap falls below 1.5V, the input seen by the RTime pin changes from a 1 to a 0 and the counting stops. RTime returns the 16-bit count in the variable specified in the instruction.

Figure 4 is a storage-scope trace of RTime in action. Remember, although the trace looks like a capacitor-discharge curve because the measured voltage is dropping over time, the capacitor is actually charging. We're just measuring it from underneath, so to speak.

RTime leaves a lot of design details to the user — the most important being for a given combination of resistor and capacitor, what value will the instruction return? That's where Electronics 101 comes in.

When a capacitor charges or discharges through a resistor, it follows an exponential curve, like the 'scope pictures of Figures 2 and 4. Initially, the cap charges or discharges quickly, then tapers off. Although curves like this are usually accompanied by some awful math, there's a simple formula for determining how long a given resistor/capacitor combination will take to charge or discharge to the 63-percent point. This value is called the time constant, and it's often symbolized by the Greek letter tau (τ). The formula is:

$$\tau = R \times C$$

For example, the time constant for a 10K resistor and a 0.1 μF capacitor:

$$\tau = (10 \times 10^3) \times (0.1 \times 10^{-6}) = 1 \times 10^{-3}$$

If you were charging a capacitor from 0V to 5V, it would reach 63 percent of 5V (3.15V) in 1 millisecond. If you were discharging that same RC combination from 5V to 0V, it would hit 63-percent discharged (or 37-percent charged; 1.85V) in 1 millisecond.

For the RTime instruction, what we really want to know is how long it will take for the capacitor voltage to go from 5V to 1.5V. See, 1.5V is the logic threshold, the point below which a BS2 pin reads 0 and above which it reads 1. It is therefore the trip point at which the RTime instruction stops counting. Calculating how long it will take for a given RC combination to reach this point is just another textbook formula:

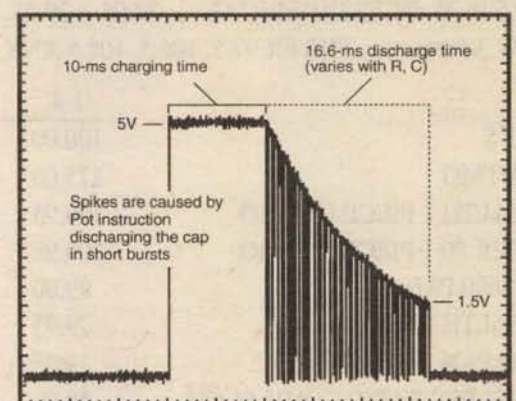
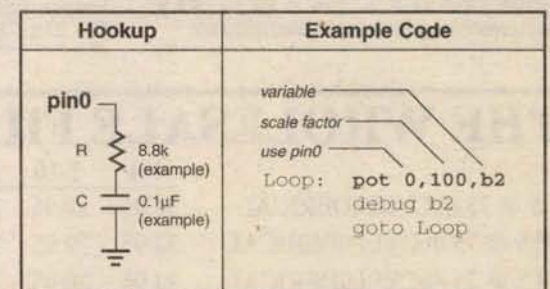
$$\text{time} = -\tau \left[\ln \left(\frac{V_{\text{final}}}{V_{\text{initial}}} \right) \right]$$

In the formula above, the symbol ln means natural logarithm; it's a key found on most scientific calculators. Let's see how long it would take for our 10K resistor and 0.1 μF capacitor to go from 5V to the logic threshold of 1.5V:

$$\text{time} = -1 \times 10^{-3} \left[\ln \left(\frac{1.5}{5.0} \right) \right] = 1.204 \times 10^{-3}$$

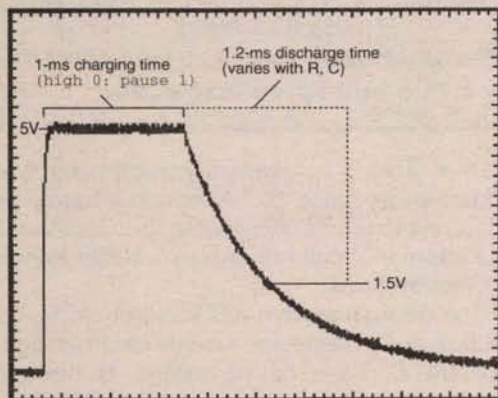
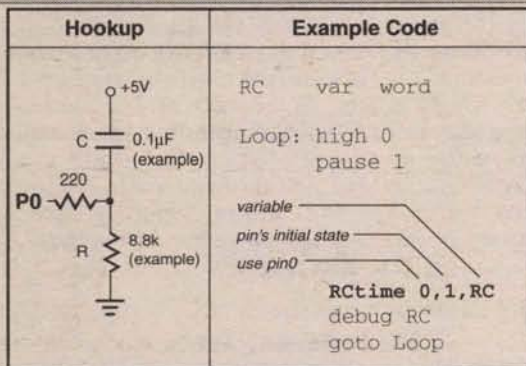
About 1.2 milliseconds after RTime begins, the voltage at the lower leg of the capacitor will hit 1.5V, and RTime will return with a count of 2 μs units in its variable. Since 1.204 milliseconds is 1204 μs, that count would be 602 in 2 μs units.

Since RTime always goes from 5V to 1.5V (when configured as shown in the manual), and always works in 2 μs units, we can derive an easy-to-remember version of the formula that can tell us



Figures 1 & 2. Pot hook-up diagram / example code (top) and storage-oscilloscope trace (bottom).

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Figures 3 & 4. RCtime hook-up diagram / example code (top) and storage-oscilloscope trace (bottom).

how many units RCtime should return for any given combination of R and C:

$$\text{RCtime units} = 600 \times 10^3 \times R \times C$$

OR

$$\text{RCtime units} = 600 \times R \text{ (in k}\Omega\text{)} \times C \text{ (in }\mu\text{F)}$$

A few final notes about Pot and RCtime are in order. First, you may be wondering why Parallax changed this function so radically. It has to do with

timing. The BS1's internal clock runs at 4 MHz, and it measures time in units of 10 μ s. If Pot worked like RCtime, the BS1 could only count to 120 in the 1.2 ms it takes for a 0.1 μ F cap to discharge through a 10K resistor. By discharging the cap in small sips, Pot extends the discharge time, allowing it to count much higher.

This also means that Pot takes much longer to execute for a given combination of R and C. The measurements shown in Figures 2 and 4 used the same resistor (a pot set to 8.8K) and capacitor (0.1 μ F, 5-percent tolerance). The BS1 took 26.8 ms overall to make the measurement; the BS2, just 2.54 ms. Both of those figures include pre-measurement charging time.

Another difference between the instructions is that RCtime is fairly linear in its response, while Pot is not. For example, if RCtime returns a count of 100 for a 2K resistance, you can predict that it will return approximately 200 for 4K. Its response becomes less linear with very short time constants due to the increased significance of the time required for the instruction to begin its measurement loop.

The BS1's Pot instruction is slightly nonlinear. Check out application note #7 in either the Parallax BS1 series or in the *Counterfeit Development System* manual. A graph of Pot readings versus resistance shows a noticeable curve.

This difference in response is why you can't just adapt the program from that BS1 app note to work with the BS2. You have to go back to the beginning of the process described in the app note and generate a new power-series equation to match the combined characteristics of the BS2 and thermistor.

In Figure 3, you may have noticed that I used a larger value resistance in series with the I/O pin than shown in the Parallax manual. They say 10 ohms; I use 220. The purpose of this resistor is to

protect the BS2 I/O pin from being damaged when the value of R is near 0 ohms and the pin is output high. This amounts to a short circuit from +5V to ground through the I/O pin.

A 10-ohm resistor will limit this short-circuit current to 500 mA. (The current would actually be less, due to the on-resistance of the I/O pin itself, but you get the idea.) That current is 25 times the rated 20-mA maximum for a Stamp I/O pin! Since the time that the pin is output high is supposed to be brief (about 1 ms), the pin should not be harmed. The advantage of using such a small resistance is that it ensures that the capacitor will be fully charged very quickly.

My logic in using a 220-ohm resistor, which would hold the short-circuit current to just 23 mA, is that it's foolhardy to rely on a program being completely free of bugs in order to prevent damage to an expensive component like the BS2-IC. How does this choice affect the charging time of the capacitor? Electronics 101 says that a capacitor is 98 percent charged in four time constants: $4 \times R \times C$. With a 220-ohm resistor and a 0.1 μ F capacitor, that's:

$$\text{Charge time} = 4 \times 220 \times (0.1 \times 10^{-6}) = 22 \times 10^{-6}$$

The capacitor is almost completely charged in 22 μ s — far, far less than the 1 ms allotted by the program.

Finally, keep in mind that RCtime is actually more of a general-purpose timing instruction than its name implies. All it really does is change a selected pin to input and count the number of 2 μ s intervals while that pin remains in a specified state (1 or 0). In this way, it's much like the PBASIC instruction Pulsin, except that it doesn't wait for an initial edge to start counting.

This can be very handy. Take BS1 application note #12, Sonar Ranging (also found in the Counterfeit manual). That application uses Pulsin to measure the time required for an ultrasonic

pulse to travel out to some reflective object and back, in order to measure the distance. To give Pulsin a complete pulse to measure, the application requires that the ultrasonic receiver be positioned so that it can hear the ultrasonic transmitter. Using RCtime would make this trick unnecessary.

Strings in EEPROM

The BS2's Serout and Debug instructions include all kinds of options, including one for outputting two different styles of strings from RAM. A string is a sequence of bytes — frequently a snippet of text.

When I saw

Listing 1. BASIC-Style Strings for the BS2

' Program: BSTRING.BS2 (Demo of BASIC-style counted strings in EEPROM)
' This program shows how to use the DATA statement to store counted strings in EEPROM, and how to retrieve these strings for serial transmission.

' Define constants for serial communication with the PC through the built-in serial connector at 9600 baud. Note that this is compatible with the debug window — if the window is on the screen, sending data to the built-in connector at 9600 baud will display it. The debug window doesn't even care whether the serial data is inverted or not! This provides a handy check of serial comms without leaving the STAMP2.EXE host software.

builtIn con 16 ' Pin number for built-in serial connector.
baud con 84 ' Baudmode constant for 9600, non-inverted.

' BASIC strings begin with a byte value (0 to 255) that specifies the number of characters in the string, followed by the characters themselves. In PBASIC-2, this translates to DATA statements that look like this:

ADDRESS CONSTANT	LENGTH (BYTES)	STRING DATA (ASCII CHARACTERS)
title	DATA 19,	">>> HELLO DOLLY <<<"
phrase1	DATA 12,	"Hello, Dolly"
phrase2	DATA 17,	"Well hello, Dolly"
phrase3	DATA 29,	"It's so nice to have you back"
phrase4	DATA 16,	"where you belong"

' The subroutine that gets BASIC-style strings requires a variable to count out the bytes of the string as it fetches them. Since we're using a single byte to specify length, strings can't be longer than 256 characters. We're using a word variable for strCnt, since it will also be used to specify the ending address of the string, which can range from 0 to 2047.

strCnt var word ' Counter for stringOut.
char var byte ' Character (byte) to send via Serout.

strAddr var word ' Base address of the string.
i var nib ' Small (0-15) counter for part 2 of demo.

' Our demonstration program will retrieve the strings one at a time and print them to the debug screen on the PC. A subroutine handles the details of getting the bytes and feeding them to serout.

demo:
debug cls ' Open a clear debug window.
strAddr = title ' Specify which string
gosub stringOut ' and display it in debug window.

pause 2000 ' Take a 2-second intermission.

' Now we'll run through the strings in order, courtesy of a lookup table containing their addresses.

for i = 0 to 3 ' For each of 4 phrases.
serout builtIn,baud,[cls] ' Clear the screen.
lookup i,[phrase1,phrase2,phrase3,phrase4],strAddr ' Get a phrase.
gosub stringOut ' Send to screen.
pause 1000 ' Time to read phrase.
next ' Next phrase until done.

STOP ' End of program.

' Here's the subroutine that reads strings. To use it, place the address of the string, assigned by its DATA statement, into the variable strAddr. Note that the first line of this routine, "read strAddr:strCnt", is equivalent to the BASIC LEN function, which returns the length of a string. This is the primary advantage of BASIC strings — the ease with which you can retrieve length info.

stringOut:
read strAddr:strCnt ' Get the number of bytes in the string.
strCnt = strCnt + strAddr ' Set the endpoint of the string.
for strAddr=strAddr to strCnt ' For each byte of the string:
read strAddr:char ' put the byte into char
serout builtIn,baud,[char] ' and send it out the port.
next ' Until all bytes are sent.
return

Stamp Applications:

these RAM-string options in the BS2 manual, I assumed that there were complementary ones for EEPROM strings. After all, the manual makes a big show out of the simple and elegant way you can use the DATA statement to stuff all kinds of goodies, including strings, into EEPROM.

Unfortunately, there isn't a correspondingly elegant way to get those strings back out.

We'll fix that. Listings 1 and 2 present a couple of BASIC subroutines that make up for the missing EEPROM string options, and show the difference between the ways that BASIC and C store strings.

In BASIC, a string begins with a length byte containing a count of the number of characters (bytes) in the string. This lets BASIC's LEN() function quickly determine string length — all it does is read that first byte.

In C, a string begins with the first byte of the

Sources

Send questions, suggestions, or requests for future Stamp Applications to:

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FAX (520) 459-0623

E-Mail (via CompuServe) at 72037,2612
Internet 72037.2612@compuserve.com

Scott offers Stamp-related kits, including:

The Counterfeit controller, a kit alternative to

the BASIC Stamp, is \$29.00. Double- and quad-speed options are \$2.00 and \$4.00, respectively. The Counterfeit Development System, required to program Counterfeits, is \$69.00 and includes a 150-page manual, downloading cable kit, Parallax software, and one Counterfeit controller kit.

Visa, MasterCard, and American Express accepted for phone/fax orders. Personal checks and money orders are welcome for mail orders.

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E-Mail info@parallaxinc.com

Listing 2. C-Style Strings for the BS2

* Program: CSTRING.BS2 (C-style null-terminated strings in EEPROM)
* This program shows how to use the DATA statement to store C-style strings in EEPROM, and how to retrieve these strings for serial transmission.

* Define constants for serial communication with the PC through the built-in serial connector at 9600 baud.

builtIn con 16 * Pin number for built-in serial connector.
baud con 84 * Baudmode constant for 9600, non-inverted.

* C strings end with an end-of string marker: a byte containing 0, also called a "null" or "ASCII null." You can store such strings in EEPROM like so:

ADDRESS CONSTANT	STRING DATA (ASCII CHARACTERS)	NULL
title	DATA " >>> HELLO DOLLY <<< "	0
phrase1	DATA "Hello, Dolly",	0
phrase2	DATA "Well hello, Dolly",	0
phrase3	DATA "It's so nice to have you back",	0
phrase4	DATA "where you belong",	0

* The subroutine that gets C-style strings requires one less word variable than its BASIC counterpart.

char var byte * Character (byte) to send via Serout.
strAddr var word * Base address of the string.
i var nib * Small (0-15) counter for part 2 of demo.

* Our demonstration program will retrieve the strings one at a time and print them to the debug screen on the PC. A subroutine handles the details of getting the bytes and feeding them to serout.

demo:
debug cls * Open a clear debug window.
strAddr = title * Specify which string
gosub stringOut * and display it in debug window.

pause 2000 * Take a 2-second intermission.

* Now we'll run through the strings in order, courtesy of a lookup table containing their addresses.

for i = 0 to 3 * For each of 4 phrases.
serout builtIn, baud, [cls] * Clear the screen.
lookup i, [phrase1, phrase2, phrase3, phrase4], strAddr * Get a phrase.
gosub stringOut * Send to screen.
pause 1000 * Time to read phrase.
next * Next phrase until done.

STOP * End of program.

* Here's the subroutine that reads C strings. To use it, place the address of the string, assigned by its DATA statement, into the variable strAddr:

stringOut:
read strAddr, char * Get the character.
if char <> 0 then continue * If char is 0, then return
return
continue:
serout builtIn, baud, [char] * else continue
strAddr = strAddr + 1 * and send char out the port.
goto stringOut * Point to next character in string.
Repeat until char = 0.

string itself, and ends with a byte containing 0, also known as an ASCII null. As you'll see from Listing 2, this makes the code to read this kind of string faster and saves one variable used as a counter.

Both approaches can accommodate an empty string, and both would express it in the same way: a single byte containing 0.

Writing BASIC code to read out these strings is an imperfect solution. Both the BASIC and C string routines take 2 ms or more to fetch each byte of a string. This means that no matter how fast a serial data rate you use, you'll never get more throughput (actual number of bytes/second sent) than a 4800-baud data stream.

If this turned out to be a real problem in an application, and if all of the strings were short, you could transfer them from EEPROM to RAM, then send them. It would take the same amount of time overall, but reduce the time that the BS2 tied up the serial link.

I've lobbied Parallax to add EEPROM-string capabilities to future revisions of the PBASIC-2 firmware.

BASIC for Beginners

For several columns I've been talking about Boolean logic and its applications in IF/THEN decisions and bit manipulations. Throughout this discussion, I have deliberately skirted the issue of numbering systems.

Our experiences with the logic operators demonstrated why it's sometimes necessary to write numbers out in a way that lets you examine individual bits: It's the only way to quickly grasp the effects of the Boolean operators.

Without further ado, let's look at the numbering systems supported by PBASIC.

Decimal. This is our everyday numbering system, also known as "base 10." Although it hardly needs further explanation, examining the familiar decimal system in detail will give us a better handle on the other systems.

The decimal system has 10 symbols: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. Therefore, a single decimal digit can represent a range of 10 values, 0 through 9, depending on which of the symbols it holds.

To represent numbers larger than 9 in decimal, we tack on additional digits to the left. For example, when counting upward, we say, "0, 1, 2, 3...9, 10, 11..." It's probably been a long time since you gave that sequence any thought, but think about it now: When you count past the largest number that you can represent in a digit (9), you reset that digit to 0, and increase the next digit to the left by 1. You then continue counting, as before, in the lowest digit, until it once again exceeds the largest number symbol.

Each digit in the decimal system expresses a number multiplied by a power of 10. Yup, even the one's place is really a multiple of a power of 10 — 10 to the zero power (10⁰). Remember that any number raised to the power of 0 is equal to 1. This fact will be important later.

Here's a quick analysis of a three-digit decimal number, 172:

Digits:	1	7	2
Value:	1 x 10 ²	7 x 10 ¹	2 x 10 ⁰

A quick summary of the decimal system:

- The root of decimal, *deci*-, means 10.
- The decimal system has 10 symbols, capable of representing values from 0 to 9.
- Digits of decimal numbers have values based on their positions in the number. Each digit represents a value 0 through 9, multiplied by a power of 10.

Binary. We can figure out a lot about the binary system (aka "base 2") by making a few quick changes to the summary of the decimal system above:

- The root of binary, *bi*-, means 2.
- The binary system has two symbols, 0 and 1.
- Digits of binary numbers have values based on their positions in the number. Each digit represents a value of 0 or 1, multiplied by a power of 2.

Binary digits are called *bits*, derived from binary digit.

Binary is the number system of digital circuits and computers. The reason is the ease with which

electronic circuits can produce, sense, and store two discrete voltages representing 0 and 1. Normally, a 0 is a low voltage, close to 0V, and a 1 by a high voltage, close to the system power supply (often 5V as in the Stamps).

Counting in binary works just like decimal, but new digits pile up faster. For example, a four-digit decimal number can represent values to 9999, while a four-digit binary number maxes out at binary 1111, the equivalent of decimal 15. Here's how you would count from 0 to 1111 in binary. Note that it follows the counting rules we reviewed in decimal above.

binary	decimal	binary	decimal
0000	0	1000	8
0001	1	1001	9
0010	2	1010	10
0011	3	1011	11
0100	4	1100	12
0101	5	1101	13
0110	6	1110	14
0111	7	1111	15

When writing binary numbers, it's necessary to label them as binary. Otherwise, they can be confused with decimal numbers by people or programs. In the example above, 1111 could be mistaken for "one thousand, one hundred and eleven" if we didn't label it in some way. PBASIC uses a percent sign in front of a binary number: %1111 is binary; 1111 is decimal.

Because binary is so often associated with computers, we often refer to standard-sized groups of bits corresponding to the physical or operational capacity of the circuit or computer. The best-known of these is the *byte* — a group of eight bits. PBASIC runs on a controller that processes data in bytes, but through clever programming, it also

allows you to manipulate 16-bit words, or individual bits. PBASIC2 (the BS2 flavor) also supports processing of *nybbles*, the play-on-words name for groups of four bits, and the basis of the hexadecimal numbering system that we'll look at next. Before we do, let's analyze a typical binary number, %1011:

Digits:	1	0	1	1
Value:	1×2^3	0×2^2	1×2^1	1×2^0

In case those powers of 2 are not on the tip of your tongue, 2^0 is 1 (as any number raised to the zero power); 2^1 is 2; 2^2 is 4; and 2^3 is 8.

Hexadecimal. Our next numbering system, which is also known as hex or "base 16," serves as a kind of shorthand for representing binary numbers. In summary:

- The roots of hexadecimal: *hex-* means 6, and *deci-* means 10; combined, they mean 16.
- The hexadecimal system has 16 symbols, consisting of 0 through 9 (as in decimal) and A, B, C, D, E, and F, representing the decimal values 10 through 15.
- Digits of hex numbers have values based on their positions in the number. Each digit represents a value of 0 through 15, multiplied by a power of 16.

Hex digits correspond to four bits, so they may be referred to as nybbles, or simply as hex digits.

Hex is handy for representing binary numbers in a compact way, since each digit corresponds neatly to exactly four bits. If you can memorize the binary equivalents of the hex counting sequence from 0 to F, you can convert any hex number to binary by merely substituting the corresponding

four bits for each hex digit. Here are the first 18 hex numbers:

hex	decimal	hex	decimal
0	0	9	9
1	1	A	10
2	2	B	11
3	3	C	12
4	4	D	13
5	5	E	14
6	6	F	15
7	7	10	16
8	8	11	17

Since hex numbers can look like decimal ones, PBASIC uses the dollar-sign symbol (\$) to label them. The hex equivalent of decimal 30 would be \$1E in PBASIC.

Here's an analysis of a three-digit hex number, \$A3F:

Digits:	A	3	F
Value:	10×16^2	3×16^1	15×16^0

To work out the decimal equivalent, just do the math and add the answers. I'll help by supplying the powers of 16: $16^0 = 1$; $16^1 = 16$; and $16^2 = 256$. (Answer: 2623)

Wrapup. You'll encounter those three numbering systems often in reading PBASIC code here and elsewhere, so it pays to get comfortable with them. If you don't already have one, consider getting a calculator that has computer-math conversions built in, like the popular and inexpensive HP20S.

Next time, we'll take a look at how bytes are used to represent text in the ASCII (*asskey*) system of symbols. If you're planning to use PBASIC's serial communication capabilities, an understanding of ASCII is a must. **NV**

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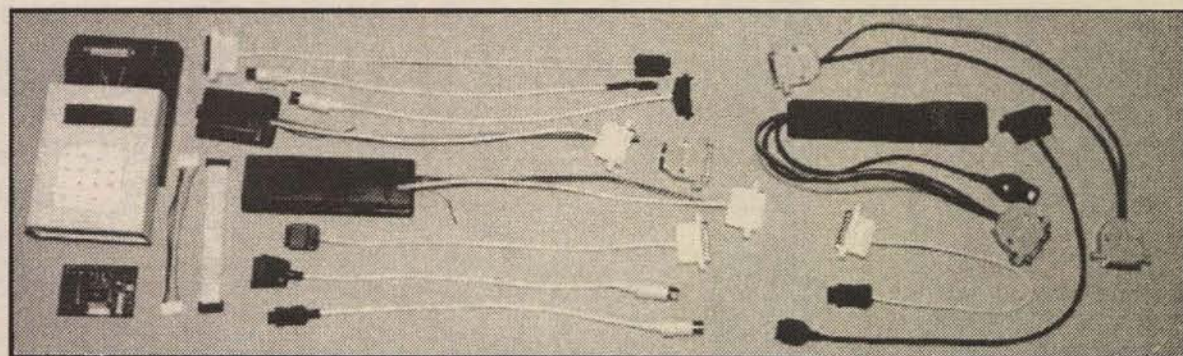
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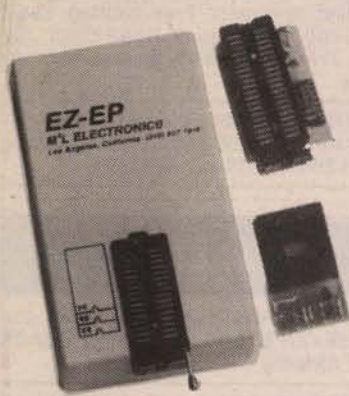
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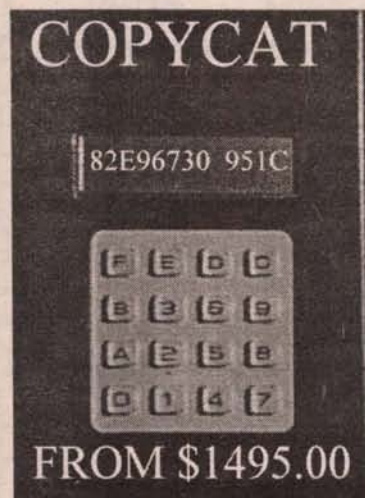
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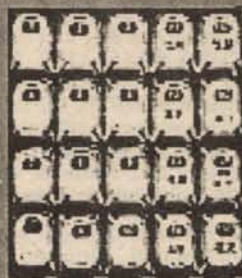
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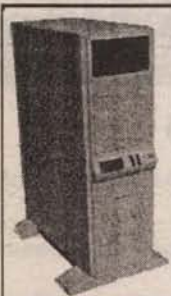
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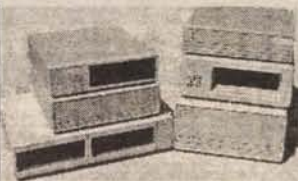
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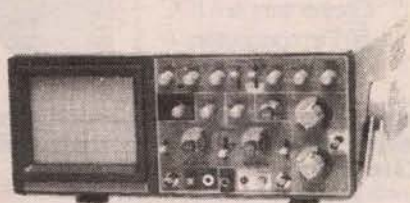
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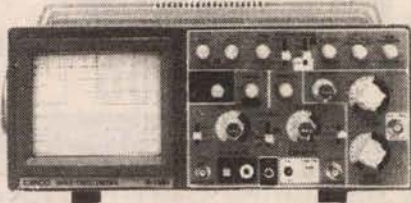
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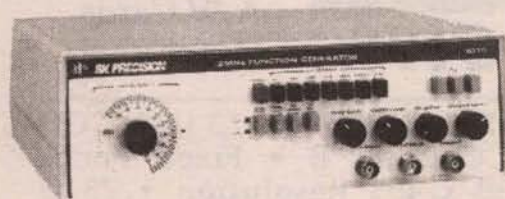
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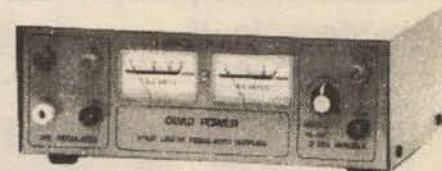
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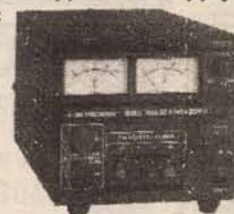
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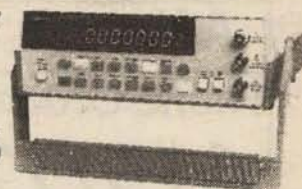
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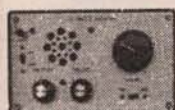


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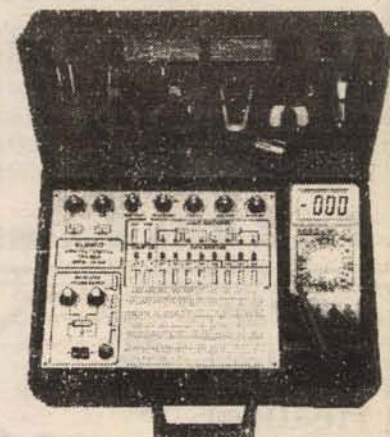
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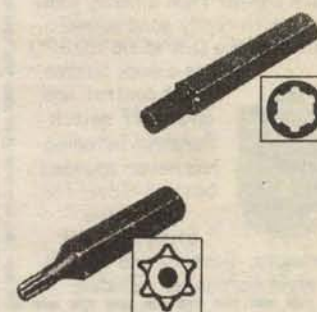
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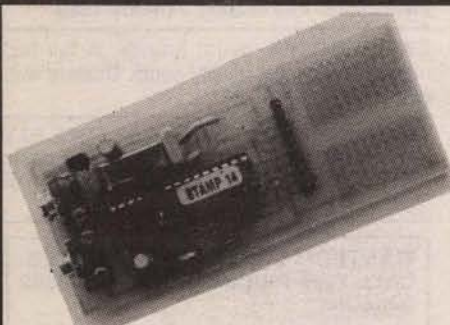
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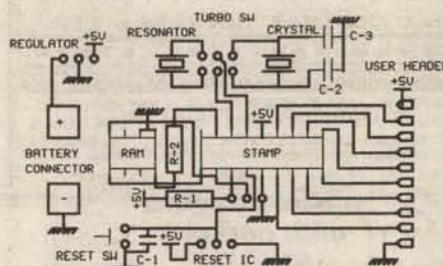
Assembly is quick and easy - solder in the IC sockets, reset switch, turbo switch and battery snaps. Finish up by

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DC TURBOSTamp \$29.95
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Includes DC TURBOSTamp kit, manual, software and programming cable kit.

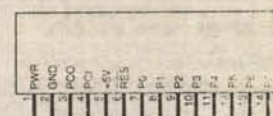
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Major credit cards welcome. Shipping/handling \$ 4.00 (ground), 2-day and next day shipping available at higher rates.



First-time buyers will need a means to program the **TURBOSTamp**. If you already have a programming package for the BASIC STAMP I from Parallax, you're all set and ready to go since the **DC TURBOSTamp** is completely compatible. Otherwise we suggest either the **TURBOSTamp** Starter Pak (which includes a **TURBOSTamp** kit) or one of the Parallax BASIC STAMP Starter Kits (which include a BS-1 or BS-2 Stamp module and carrier board).

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BS-1 Basic Stamp I Module	\$34.00
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Nuts & Volts Magazine/May 1996 69

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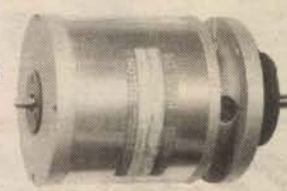
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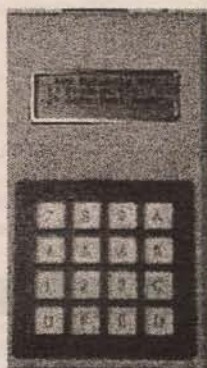
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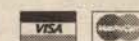
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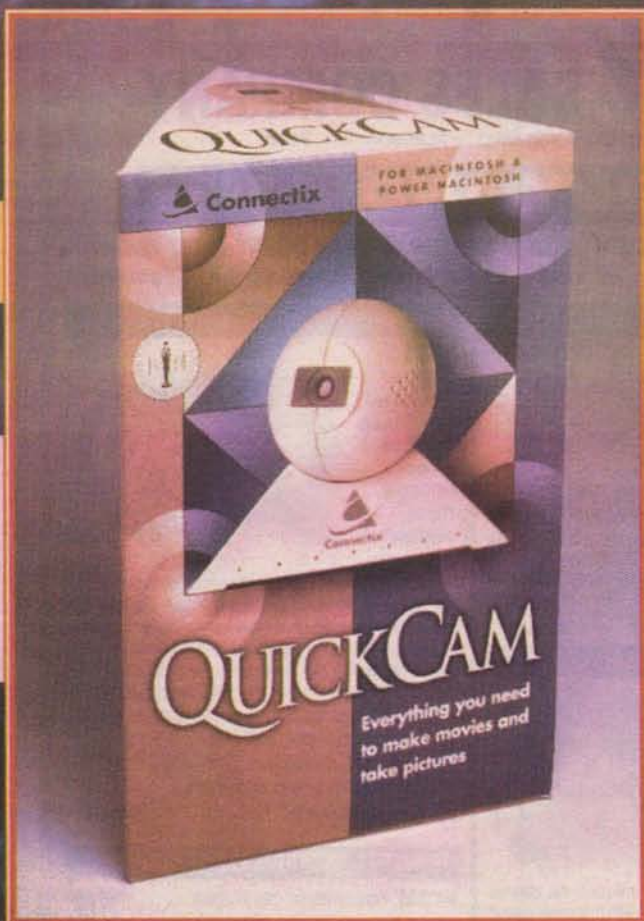


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MICRO-Controller

\$100 QuickCam: Useful Utility or Ball of Fun?

by
Dr. Michael W. Ecker



I sure wish I had one of these several years ago ...

I was writing a column for a regional "throwaway" publication in the northeast Pennsylvania market. The editor wanted my picture to appear above each column.

Have you ever heard of a writer — or anybody else — who did not want his (or her) picture published? Naturally then, I provided a photo that I mailed to the magazine.

It was scanned in, evidently.

Upon first glance, the picture did not appear that bad upon publication. However, it left something to be desired. But what?

A closer look at the tabloid showed it was a tad grainy from the scanning. That was not my sole complaint. Even if I had loved it, I did not have the computer file of my picture, so I could not re-use it in my own publication or elsewhere. Not owning a scanner, I could not even create my own image files. Even if I borrowed one or used one elsewhere, I would not have the flexibility to create more images. Moreover, I am not even a camera buff!

And even if you have a camera and a scanner, do you want to go through all this each time?

Idea: Consider a camera connected to a computer, one that can instantly take a picture and produce an image file. That file not only can be saved and stored, but edited. You can take as many pictures as you desire, not have to develop them, and then not have to scan those in. Instead of buying film, you store images on disk. The image files are available whenever you want them.

With these you can add photos to newsletters, magazine columns, personalized stationery, and more. In fact, wouldn't it be nice to be able to produce a movie as well?

This is exactly what you get with the QuickCam.

To The Rescue

Early last year, the Connectix Corp. of San Mateo, CA, changed the contours of the technology market. Until that time, Connectix had been known first to Macintosh users and later to Windows users as a software-only company. Known best for such utilities as Speed Doubler and RAM Doubler, Connectix changed this, too, as it announced and released its revolutionary new device.

The QuickCam is a digital-video camera costing about \$100.00. Initially for the Macintosh only, it was released in a similar version for PC/Windows later last year. Though it is black/white only, the QuickCam sports 16 shades of gray. According to one report, it could appear soon in a color-image version as well, but presumably at a higher price.

Once you have installed the hardware and software (described elsewhere), click on the appropriate icon or filename to begin. The screen then presents a window within which you see whatever the camera sees from within a 65-degree viewing angle. If people are around and moving, the camera shows these on the screen. This makes for a nice teleconferencing feature for present and future telecommunications. Place one of these on each PC so "tele-callers" can see each other. Indeed, this was one of the most striking features I reported on at last year's PC Expo in New York City (though I did not note whether they were using QuickCam cameras).

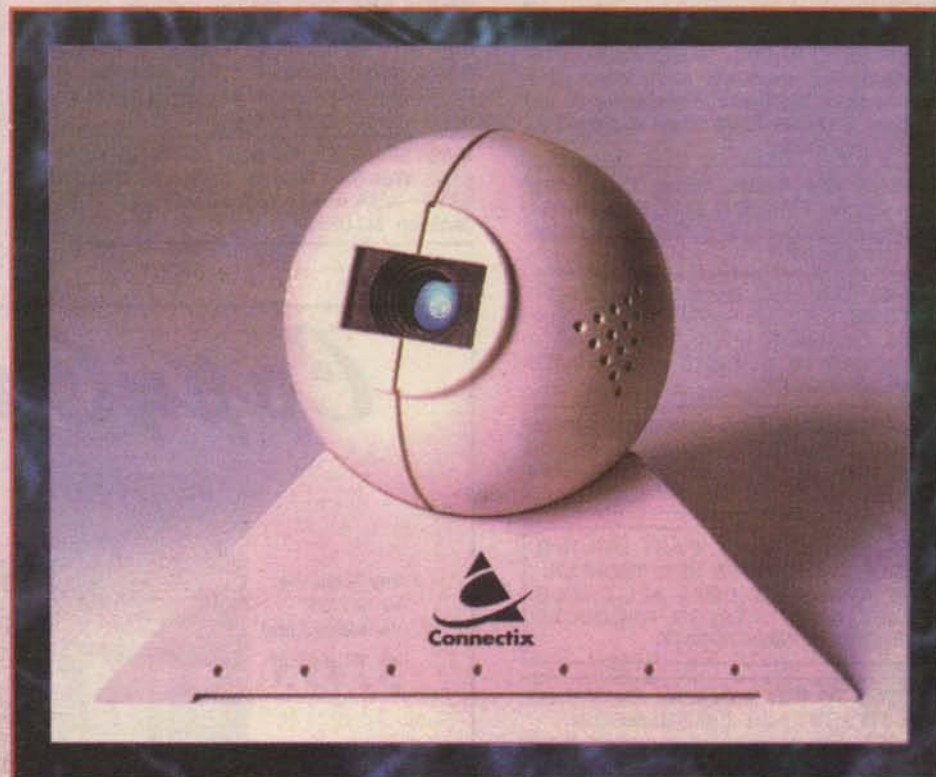
How does QuickCam do? The image you display can go as high as 320 x 240 pixels, which is exactly one-quarter of a standard 640 x 480 VGA screen. Connectix refers to this

as a "full" image. You can also display one-half or one-quarter of this full image. You might want to use a smaller size because the animation in full image is a bit choppy. That is, the number of frames per second is insufficient to present the illusion of smooth motion. At the smallest size, you can capture up to 24 frames per second.

I have many times done the following at full image: I've looked up at the camera and smiled, and then quickly dropped my eyes to the monitor a few inches below. Each time — whether on Mac or PC — I was able to see my camera-ready, smiling image just prior to dropping my eyes.

This is not necessarily bad. It's good to get a preview for how your picture will look. With a smaller

There are also two easy-to-miss triangular configurations of 15 dot-size openings each. This appears on both Mac and Windows versions, with an important difference: The dots conceal a built-in microphone on the Macintosh version only. However, those who have their own microphone for the Mac are advised even by Connectix itself to stick with what they already have because of better sound quality with a dedicated mike. Nevertheless, it makes the QuickCam a terrific value for those who lack one, since the QuickCam's mike is good enough for general Mac sound control. As for Windows, it appears to be purely decorative on



image, however, the QuickCam has fewer pixels to display on screen and does a better job of keeping up. You will probably want the one-half size for movies and full-size for stills.

Making The Connection

Physically, the camera is housed in the shape of a ball barely one inch in radius. An aperture at the front of the ball shows the lens. A tripod base provides a safe balance to prevent the ball from rolling away.

the PC version. More precisely, the company probably just used the same housing for both versions. (Connectix, however, does sell a microphone as an optional accessory.)

At the back of the ball is a thin cable that splits at the end that runs to the computer. Each of the Mac and Windows versions requires two separate connections. In the Windows version, one part goes to a parallel port and the other has a pass-through connection to the key-

Lights, QuickCam, Action!

board port. The Mac has a similar set-up, but the port is a serial port (either modem port or printer port as selected by the user). Both versions sport software included along with a manual. The PC side includes a version of Microsoft Video for Windows; for the Mac there is QuickTime. Thus, you can play the movies you create. Other than the modifications in software and the adapters for computer connections (as well as the microphone), the versions appear similar.

One problem most users will encounter is having no available ports. Most PC users buy a printer as the very first peripheral, and it almost always uses up the first parallel port. Most do not have a second parallel, and thus they need a port switcher — also known as an AB switch (usually about \$12.00 to \$35.00, but higher if you want more than two devices attached or want automatic switching).

It is important to get a port switch that switches all pins! The first switch I bought for my Pentium's QuickCam did not work, probably for this reason. So, I got one from Connectix itself, which sells a proper one as an optional accessory for \$20.00.

Mac users need not gloat, as they have a similar concern with serial ports. Most Macintoshes quickly got hooked up with a printer in the printer port and a fax-modem in the modem port. Since Macs are disproportionately used in desktop-publishing well beyond their numbers, they tend to have plenty of other devices attached as well, such as graphic tablets and scanners.

I tested and continue to use both the Macintosh and PC/Windows versions. The Macintosh I use is a Performa 475, a fairly typical '040 Mac enhanced with 12 megabytes of RAM, a second hard drive, and multimedia package added later. The PC I use is not unusual, either: a 75-MHz Pentium enhanced with 16 megabytes of RAM, a second 850-MB hard drive, and multimedia that came with the system. (I'm still running Windows for Workgroups 3.11 on this Pentium, but any version of Windows, including Windows 95, will do.) I definitely consider the QuickCam as an integral part of each computer's multimedia capability.

Competition: What Don't You Get?

There are other companies — Sony and Casio being prime examples — working on or currently marketing digital-video cameras. Three important distinctions need to be noted, however.

First, most of these competitive products are not explicitly built to be

attached to, and used exclusively from, a microcomputer.

Second, most of these are far more expensive. Digital-video cameras typically cost \$500.00 to \$1,000.00 — and up.

Third, many or most of these others require opening up computers to insert a video-capture board or other hardware board.

Though this third item would hardly deter readers of this magazine, a consumer-oriented product will be more successful with something close to plug-and-play capability. The higher-priced cameras, on the other hand, give better resolution at more frames per second. However, you sacrifice your wallet as well as the direct connection feature of the QuickCam.

The combination of explicit computer connection, low price, and easy installation and use have given the QuickCam a unique niche in the lower-end PC video market. At the time when Connectix was working hard to keep up with demand, Casio announced its higher-end products in early January 1996 at Comdex in Las Vegas, NV. Casio's models such as the QV-30 are aimed at a different market, one that includes computer usage as just one component of multimedia. (At the time of the writing of this article, I understood that the company was still selling its QV-100 for \$800.00. I priced the latter model at a local Office Max super-store in late January 1996 and found it discounted to \$650.00 — though I could have sworn I saw it with a Sony label.)

Look at some of the computer catalogues, too. Serious photography work in the Mac world can require a video-capture board costing as much as \$5,000.00 for the hardware.

Application Ideas: Have A Ball!

My first use of QuickCam was to take pictures and then pick one for use in my publication. I still don't know whether I gained admirers or lost readers, but it was fun! Yet, there's more. You can create a movie, save it to disk, and then send this video to others — 15 seconds' worth of video in a Windows avi file or Mac QuickTime movie on a standard 1.44 MB floppy.

Since then, I've made homebrew stationery (on both the Mac and the PC) that includes my QuickCam-captured image. Each comes out about the same on screen, but print-outs are another matter. It is crucial that you have at least a

600 dpi laser printer (such as my Apple LaserWriter Select 360, for both Mac and PC). Higher resolution is even better, and a 300 dpi image (such as produced on my old HP LaserJet II) is too grainy.

You have a choice of format in how you save the images, incidentally. But once you start taking pictures, you'll want to gather the whole family. I found it great fun to take a picture of my wife and kids with the QuickCam, and then use a third-party morphing package to create an animation of spouses turning into each other — or son morphing into daughter.

Try these: Send out picture greetings (on disk or paper). Star in your own video. Add images to your resume or family history. Add pictures to your contact database. (If the cable were extended, could you use the camera as a background "baby-monitor?")

Compatible with After Dark, the QuickCam can act as a screen-saver. Instead of popping up fish and toasters on the screen after five minutes of inactivity, let the QuickCam do its thing!

Summary

The QuickCam is a neat hardware-software combo. It works on virtually any Windows-based PC and virtually any QuickTime-capable Macintosh. Figure on needing at least 4 MB of RAM for pictures and 8 MB for movies. Of course, you'll want some spare megabytes of hard-drive space for storage.

The QuickCam functions reasonably well, though I find that the "Take Picture" feature on the Windows version did not seem to work in the manner I expected.

If you can live with its minor limitations, the QuickCam can be a useful product, a fun product, or both. At about \$100.00, it's certainly worth finding out which it is for you. *NV*

Connectix QuickCam Digital Image Camera, about \$100.00.

Connectix Corp.
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Dr. Michael W. Ecker holds a Ph.D. in mathematics from the City University of New York (1978) and is a math professor at the Pennsylvania State University's Wilkes-Barre Campus. With over 400 publications mostly in computer magazines in the 1980s, Mike is also editor and publisher of his own Recreational & Educational Computing since Jan. 1986. Contact Dr. Ecker at 909 Violet Terrace, Clarks Summit, PA 18411 or via E-Mail mwe1@psu.edu or DrMichaelE@aol.com



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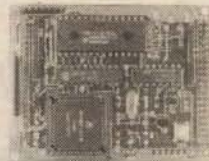
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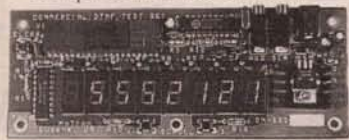
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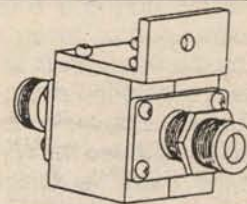
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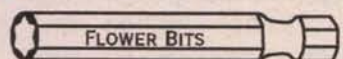
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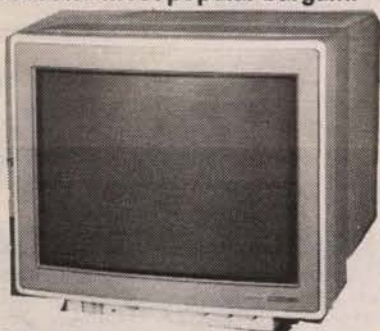


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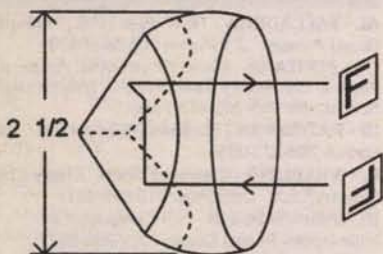
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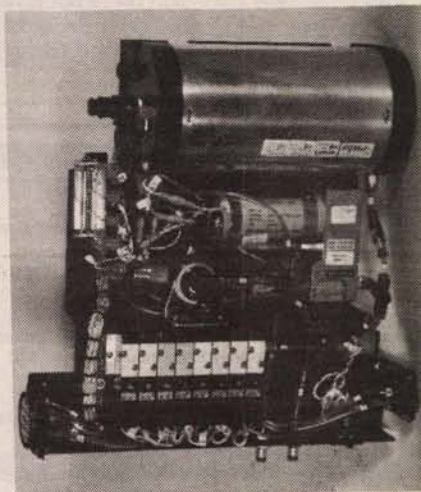


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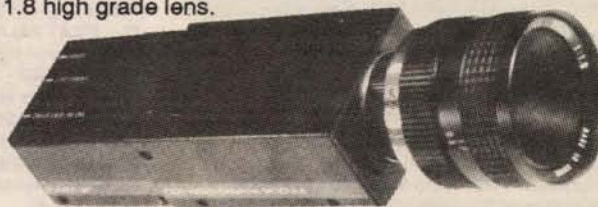
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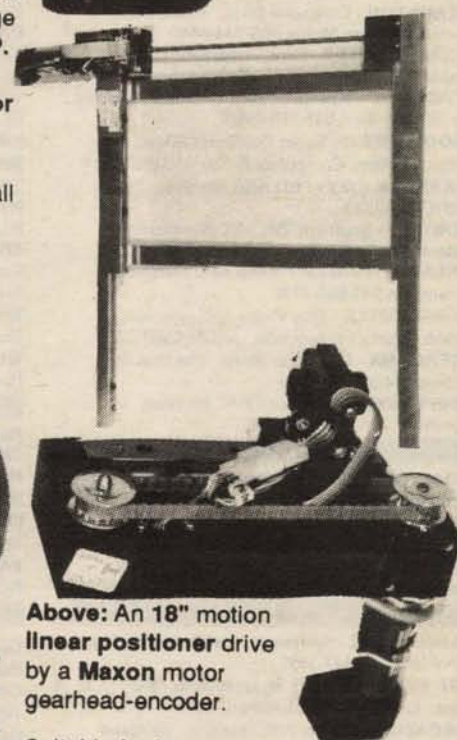
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MAY 3-4-5

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MAY 4

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MAY 4-5

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MAY 5

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WV - RIPLEY - Jackson County ARC Hamfest. Joe Pickens 304-372-5648

MAY 10-11-12

FL - LAKE LAND - Central Florida Computer Show & Ham Radio Expo. Polk County Fairgrounds. Sonny Douglas 941-647-9541 ext 300

MAY 11

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
CA - LOS ALTOS HILLS - Perham Foundation Electronics Flea Market. Foothill College, Parking

The Events Calendar is a free service limited to electronic events such as computer shows, hamfests, flea markets, etc. If your organization is sponsoring an event and would like a free listing, contact us at least 60 days prior to the event. Include your flyer, estimated attendance, name of the person to contact, and phone number.

Complimentary issues are available upon request for distribution to your attendees. A street address for UPS is required.

While we strive for accuracy in our calendar, we can not be responsible for errors or cancellations. The information contained in this column is for the use of the readers of *Nuts & Volts* and may not be republished in any form without the written permission of T & L Publications, Inc.

Lot A. 408-734-4453

CA - OAKLAND - Robert Austin Computer Show. Convention Center. 800-346-0100
CA - SAN DIEGO - Computer Show. Scottish Rite Center. 619-295-1221
IL - PEOTONE - Kankakee ARS Annual Hamfest. Will County Fairgrounds. Willis 815-472-2079
IN - INDIANAPOLIS - AGI Computer Fair. Indianapolis Events Center. 317-299-8827
NH - SALEM - Computer Show. Rockingham Park Track. Northern Computer Shows 508-744-8440
NY - Poughkeepsie - Computer Show. Mid-Hudson Civic Center. MarketPro 201-265-1075
TN - KNOXVILLE - RAC of Knoxville Amateur Radio, Computer & Electronics Show. Tennessee Valley Fairgrounds/Chilhowee Park. Carol 423-673-0475
WA - STANWOOD - Stanwood Camano ARC Hamfest. Vic Henry 360-387-7705
WI - MANITOWAC - Mancorad ARC Lakeshore Hamfest. County Expo Center. Glenn 414-684-7096

MAY 12

MI - DEARBORN - Super Computer Show. Civic Center. Computers & You 313-283-1754
NJ - SECAUCUS - Computer Show. Meadowlands Expo Center. MarketPro Shows 201-265-1075
OH - MEDINA - Medina 2 Meter Group Hamfest. Robert Romaniello 216-722-6019
PA - YORK - Computer Show & Sale. York Fairgrounds. Peter Trapp Shows 607-369-2796.

MAY 17-18-19

OH - DAYTON - Dayton ARA Hamvention. Dayton Hara Arena & Exhibition Center. 513-276-6930
OH - DAYTON - Super Computer Show & Sale. 1000 Shiloh Springs, across the street from the Hamvention. Joe 317-889-1670

MAY 18

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052
MI - TAYLOR - Super Computer Show. Democratic Club. Computers & You 313-283-1754
MI - WESTLAND - Great Lakes Computer Expo. Wayne-Ford Civic Center. 313-416-1015
PA - ALLENTOWN - Computer Show. Merchants Square. Peter Trapp Shows 607-369-2796
PA - EPHRATA - Ephrata ARS Lancaster County Hamfest & Computer Show. Ephrata Senior High School. Info: 717-484-2102, after 6pm
RI - FORESTDALE - Rhode Island Amateur FM Repeater Service Spring Auction & Flea Market. VFW Post 6342. Rick 401-725-7595

MAY 18-19

GA - AUGUSTA - Computer Show. Georgia National Guard Amory. Rick 706-868-6814
SC - HARTWELL - Lake Hartwell Hamfest. Sadlers Creek State Park. Brooks Jordan, fax 864-225-0567
VA - VIRGINIA BEACH - Computer Show. Pavilion. Pro Am Shows 804-463-1136
WA - YAKIMA - Yakima ARC Hamfest. Mark Tharp 509-965-3379

MAY 19

CA - CARMICHAEL - North Hills ARC Hamfest. Tim Lewis 916-722-7037
IL - ORLAND PARK - Orland Park Computer Show. Civic Center. 24-Hour Hotline 708-974-3123
MA - CAMBRIDGE - Flea Market. MIT. Nick 617-253-3776
MI - FARMINGTON HILLS - Super Computer Show. Farmington Hills Activity Center. Computers & You 313-283-1754
MI - FLINT - Computer Show. Holiday Inn-Gateway Centre. Five Star Productions 810-230-0988
VA - VIRGINIA BEACH - Computer Show. Pavilion. Pro Am Shows 804-463-1136

MAY 25

AZ - KINGMAN - Hualapai & Dolan Springs ARC's Hamfest. Jack Jackson 520-757-5256
CA - SAN FRANCISCO - Robert Austin Computer Show. Cow Palace. 800-346-0100
FL - POMPANO - Computer Show & Sale. Palm-Aire Hotel. Narisaam Shows 1-800-436-6707
NC - DURHAM - Durham FM Association 22nd Annual Hamfest & Computer Show. South Square Shopping Mall. Rodney Draughon 910-364-7420
NY - HAMBURG - Computer Show. Hamburg Fairgrounds. MarketPro Shows 201-265-1075
PA - PHILADELPHIA - Computer Show. Holiday Inn. Micro-Mart 609-924-2344

MAY 25-26

WY - CHEYENNE - Shy-Wy ARC Hamfest. Marty Luna 307-635-7594

MAY 26

CA - SANTA ANA - Swapmeet. ACP Parking Lot. Mary Russo 714-558-8813
FL - WEST PALM BEACH - Computer Show. Palm Beach Airport Hilton. Narisaam 1-800-436-6707
IL - CHICAGO - Chicago ARC Annual Hamfest. DeVry Institute of Technology. Jack 312-736-1587
IL - GLEN ELLYN - Computer Central. College of DuPage, Phys Ed Bldg. 708-940-7547
MD - WEST FRIENDSHIP - Maryland FM Assn Hamfest. Howard County Fairgrounds. Melvin Seyle 301-249-6147
MI - MADISON HEIGHTS - Super Computer Show. U.F. & C.W. Hall. Computers & You 313-283-1754
NY - ROCHESTER - Computer Show. The Dome Center. MarketPro Shows 201-265-1075
OH - CANFIELD - 20/9 Radio Club Hamfest. Canfield Fairgrounds. Don Stoddard 216-793-7072

MAY 27

NY - SYRACUSE - Computer Show. On Center. MarketPro Shows 201-265-1075

MAY 31-JUNE 1

NE - SOUTH SIOUX CITY - Midwest & Dakota Division Convention. Dick Pitner 712-258-1520

MAY 31-JUNE 1-2

NY - ROCHESTER - Atlantic Division/New York State Convention. Harold Smith 716-424-7184
OR - SEASIDE - Northwestern Division Convention. Randy Stimson 503-297-1175

JUNE 1996

JUNE 1

CA - SAN DIEGO - Computer Show. Scottish Rite Center. 619-295-1221
CO - LOVELAND - Northern Colorado ARC Superfest Swapmeet. Larimer County Fairgrounds. Michael Robinson 970-282-1167
IL - SPRINGFIELD - Sangamon Valley RC Hamfest. Illinois State Fairgrounds. Don 217-789-4519
MA - FITCHBURG - Computer Show. Royal Plaza Trade Center. MarketPro Shows 201-265-1075
ME - HERMON - Pine State ARC Bangor Hamfest. Hermon High School. Roger Dole 207-848-3846
NC - RALEIGH - Computer Show & Sale. NC State Fairgrounds, Scott Bldg., 1-800-859-4HAV
NJ - TEANECK - Bergen ARA Hamfest. Jim Joyce 201-664-6725
TN - NASHVILLE - Nashville ARC Hamfest. Tennessee State Fairgrounds. David 615-736-7855
WI - FRIENDSHIP - Adams County ARC Hamfest. Adams County Fairgrounds. 608-564-7887

JUNE 2

CA - LIVERMORE - Swapmeet. Las Positas College. Noel Anklam 510-447-3857

All listing information should be sent to:

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Fax 909-371-3052

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CT - NEWINGTON - Newington ARL Amateur Radio & Electronics Flea Market. Newington High School. Info: 860-666-1952

IL - PRINCETON - Starved Rock Radio Club Hamfest & Computer Show. Bureau County Fairgrounds. Bruce/Debbie Burton 815-795-2201

MA - ANDOVER - Computer Show. Ramada Rolling Green. MarketPro Shows 201-265-1075

MI - CHELSEA - Chelsea ARC Swap 'N Shop. Chelsea Fairgrounds. Alan Robbins 313-878-0363

MI - HOLLY - Fenton Area ARA Hamfest & Computer Fair. Ben Sherman Middle School. Marty 810-634-9826

NY - WOODBURY - Long Island Mobile ARC Hamfest. Mark Nadel 516-796-2366

PA - BUTLER - Breezeshooters ARC Hamfest. Butler Farm Show Grounds. George Artnak 412-854-5593

VA - MANASSAS - Ole Virginia Hams ARC Hamfest & Computer Show. Prince William County Fairgrounds. Mary Lou 703-369-2877

VA - ROANOKE - Computer Show & Sale. Civic Center Exhibition Hall. 1-800-859-4HAV

JUNE 7-8-9

TX - ARLINGTON - West Gulf Division Convention. Tom Gentry 214-442-1721

JUNE 8

AL - TALLADEGA - TRAC Fest 1996. National Guard Armory. J T Martin 205-362-0478

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

ID - RATHDRUM - Kootenai ARS Hamfest. Hal Larson 208-773-0863

IL - WHEELING - Computer Show. Chevy Chase Country Club. ComShow 312-665-4817

IN - INDIANAPOLIS - AGI Computer Fair. Indianapolis Events Center. 317-299-8827

MI - GRAND RAPIDS - Independent Repeater Assn. 16th Annual Hamfestival. Hudsonville Fairgrounds. Tom 616-698-6627

NC - WINSTON-SALEM - Forsyth ARC Hamfest, Computer & Electronics Fair. Dixie Classic Fairgrounds. Bill Patterson 910-723-7388

NJ - RIVERDALE - Split Rock & West Morris ARC's Hamfest. Nat'l Guard Armory. Bernie 201-584-5399

NY - PLATTSBURGH - Champlain Valley ARC Hamfest. Les Schmarder 518-873-2189

JUNE 8-9

GA - ATLANTA - Hamfestival. City Hall East/Town Hall Exhibition Center. Marty 404-814-9304

WA - WENATCHEE - Apple City ARC Hamfest. Greg Johnson 509-884-6314

JUNE 9

CA - OAKLAND - Robert Austin Computer Show. Convention Center. 800-346-0100

KY - ERLANGER - Northern Kentucky ARC "Ham-O-Rama '96". Lions Park. N8JMV 513-797-7252 eves

NY - DARIEN CENTER - Lancaster ARC Hamfest. Charles Koester 716-937-3592

NY - STONY BROOK - Computer Show. SUNY Stony Brook. MarketPro Shows 201-265-1075

PA - HANOVER - Hanover Area Hamming Assn's Pleasant Hill Ham & Computer Show. Pleasant Hill Fire Company. Ralph Stoffel 410-239-8451

PA - WINFIELD - Susquehanna Valley & Milton ARC's Ham & Computer Fest. Union Township Volunteer Fireman Grounds. Derek 1-800-656-6066

JUNE 14-15

GA - ALBANY - Albany ARC Hamfest & GA Section Convention. James H. Gray Civic Center. Albany ARC, POB 70601, Albany GA 31708-0601

JUNE 15

CA - SAN FRANCISCO - Robert Austin Computer

Events CALENDAR

Show. Cow Palace. 800-346-0100

NJ - DUNELLEN - Raritan Valley RC Hamfest. Columbia Park. Robert Pearson 908-846-2056
NY - CORTLAND - Skyline ARC Hamfest. Andrew Slaugh 607-753-0597
OH - MILFORD - Milford ARC Hamfest. Ed Lowe 513-248-9565

JUNE 16

MA - CAMBRIDGE - Flea Market. MIT. Nick 617-253-3776
MD - FREDERICK - Frederick ARC Father's Day Hamfest. Frederick County Fairgrounds. Info: 301-695-2633, code 6393
MI - MONROE - Monroe County Radio Communication Assn. Hamfest. Monroe County Fairgrounds. Fred 313-242-9487
OH - MACEDONIA - Cuyahoga ARS Hamfest. Rich James 216-468-2035

JUNE 22

CT - WATERBURY - Computer Show. Waterbury Four Point. MarketPro Shows 201-265-1075
FL - FORT LAUDERDALE - Computer Show & Sale. Holiday Inn-West. Narisaam Shows 1-800-436-6707
NC - SPRUCE PINE - Mayland ARC Hamfest. David Biddix 704-765-4223

JUNE 23

FL - WEST PALM BEACH - Computer Show & Sale. Palm Beach Airport Hilton. Narisaam 1-800-436-6707
NJ - NEWARK - Computer Show. Holiday Inn. Micro-Mart 609-924-2344
WI - WAKESHA - Computer Show. County Expo Center. ComShow 414-961-6003

JUNE 28-29-30

SD - RAPID CITY - Black Hills ARC Hamfest. Gary Peterson 605-343-6739

JUNE 29

KY - PADUCAH - Paducah ARA Hamfest. Executive Inn Convention Center. David Fraser 502-488-2031

JUNE 30

CA - SAN DIEGO - Computer Show. Scottish Rite Center. 619-295-1221
IL - WHEATON - Six Meter Club Hamfest. DuPage County Fairgrounds. InfoLine: 708-442-4961

JULY 1996

JULY 4

PA - BRESSLER - Harrisburg RAC Hamfest & Computer Show. Emerick Cibort Park. 717-232-6087

JULY 6

IL - WHEATON - Six Meter Club Hamfest. DuPage

County Fairgrounds. InfoLine: 708-442-4961

JULY 7

CA - LIVERMORE - Swapmeet. Las Positas College. Noel Ankam 510-447-3857
OH - LISBON - Triangle ARC Hamfest. Columbiana County Fairgrounds. Dick Sisley 330-385-1245
PA - LEHMAN - Murgas ARC's Wilkes-Barre Hamfest & Computerfest. Luzerne County Fairgrounds. Bob 717-288-3532

JULY 12-13-14

PA - LANCASTER - National Scanning's National Communications Convention. Lancaster Host Resort/Holiday Inn. 610-273-7823.

JULY 13

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves
WI - OAK CREEK - South Milwaukee ARC Swapfest. American Legion Post #434. 414-762-3235

JULY 14

PA - PITTSBURGH - North Hills ARC 11th Hamfest. Northland Public Library. John 412-487-2740

JULY 20

NJ - HARMONY - Cherryville Hamfest. Warren County Farmers' Fairgrounds. 908-788-4080, 24 hrs

JULY 21

CA - SAN DIEGO - Computer Show. Scottish Rite Center. 619-295-1221
MA - CAMBRIDGE - Flea Market. MIT. Nick 617-253-3776
PA - HOMER - Indiana County ARC Summerfest, Computer & Ham Radio Fair. Red Barn Sportsman Club. Bill McMillen 412-397-2702

JULY 27

IN - INDIANAPOLIS - AGI Computer Fair. Indianapolis Events Center. 317-299-8827
MI - MIDLAND - Midland ARC Hamfest. Midland Armory. Bill 517-832-3053

JULY 27-28

CA - SANTA ANA - Swapmeet. ACP Parking Lot. Mary Russo 714-558-8813
FL - ORLANDO - Bahia Shrine AR Unit Hamcation. Bahia Shrine Temple. Cecil Morehouse 407-281-9169

JULY 28

MD - BRUNSWICK - Mid-Atlantic DX & Repeater Assn. Swapfest. MARS Train Station. Voice BBS 301-416-8447, Box #109
MD - TIMONIU - Baltimore Amateur Television Society Hamfest & Computerfest. Timonium Fairgrounds. 410-467-4673
OH - XENIA - Hamfest & Computer Expo. Heartland Flea Market & Bingo Hall. 513-429-5403 eves.

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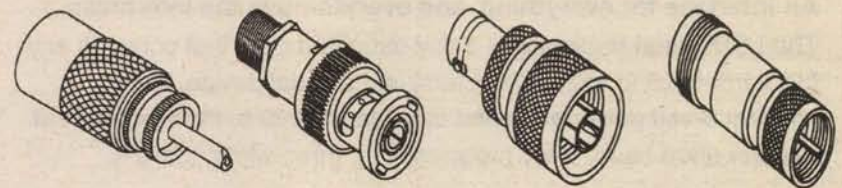
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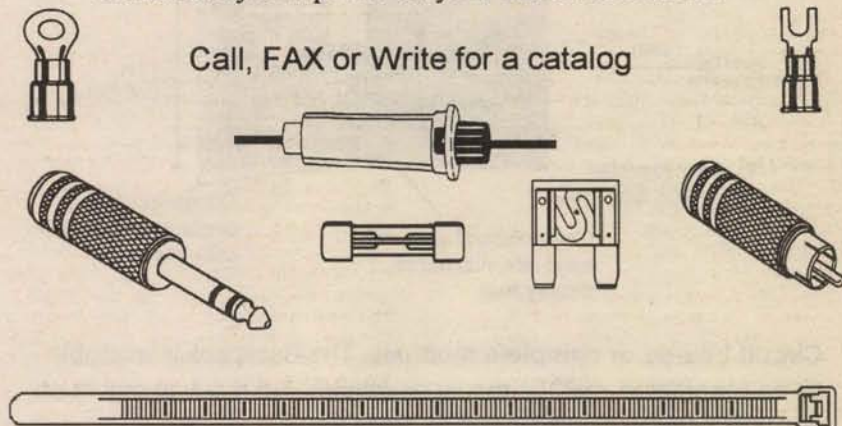
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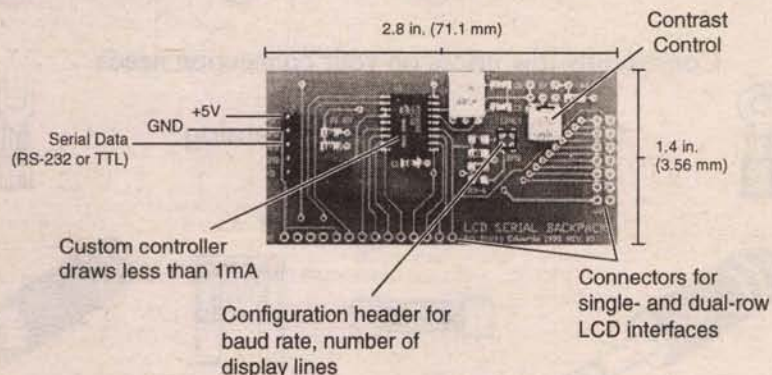
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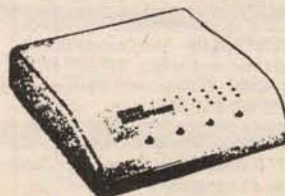
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necting a third fax to the phone line). In-

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Questions & Answers

TECH FORUM

This is a READER TO READER Column. All questions AND answers will be provided by *Nuts & Volts* readers and are intended to promote the exchange of ideas and provide assistance for solving problems of a technical nature. All questions submitted are subject to editing and will be published on a space available basis if deemed suitable to the publisher. All answers are submitted by readers and **NO GUARANTEES WHATSOEVER** are made by the publisher. The implementation of any answer printed in this column may require varying degrees of technical experience and should only be attempted by qualified individuals. Always use common sense and good judgement!

QUESTIONS

With the Commodore computer still having a hard and heavy following, and the Internet coming in hard and heavy-hitting, is there any terminal program being made or already on the market which will allow access to this bright, new world? Local providers here want an unusual set-up to be used. I love my Commodore! Please help!

5961 **John W. Humphrey**
Wilmington, NC

I have an IBM PS/1 computer. I accidentally deleted or edited the menu away. Please help me to get the menu back. Please explain it as simple as possible.

Also, can you give me a number for an IBM helpline?

5962 **Tommy West**
Fort Myers, FL

I have several CGA video cards manufactured by Sperry Corp. Some of the identifying numbers are: Persyst Color II; AX8876; DU06VGSORT Color; ASSY 12-10085-03 REV-E. I would like to know the function of jumper pins E1 to E30 and the purpose of J3 and J4. Any help will be appreciated.

5963 **William Glaske, Jr.**
Rockford, MI

Why do old vacuum tube communications receivers have an antenna-tuning variable capacitor at the input, which works so well, and modern transceivers have none?

5964 **David H. Hubel**
Boston, MA

I'm looking for techniques to find/detect subliminals put in television programming. Several documented examples of this were found on television.

5965 **Al Trautman**
Lydia, LA

Does anyone know the inductance values and current handling capabilities of common single-winding fluorescent light ballasts? I had a wild idea they might be useful as a sub for large chokes in tube power supplies and/or audio circuits. Are there any in the ballpark of 30 Henrys to 700 Henrys? General information will be very useful.

5966 **John Smith**
Collison, IL

A circuit I am designing requires a way to latch a 5 or 6 VDC relay in the on position, in the same manner as a latching relay, i.e., one input is the "set," the other is the "reset."

A pulse is sent by a momentary pushbutton, a diode matrix will route the pulse to the right lead.

My first design used a dual-coil latching relay, but at \$8.00 each, I was hoping to be able to make a simple circuit to hold a power relay on without a separate latching relay.

Could the "latch" be made from a simple transistor, SCR, or diode arrangement?

5967 **Miles Wilson**
Watson, PA

I just bought a Play Station for myself and I would like to know if there is any way I can play any computer CD-ROM games or any Sega Saturn games on it.

5968 **Roberto Gonzalez**
South Bend, IN

Is there any way I can change a circuit or something on my ID Caller so I can read blocked or cellphone calls on it?

5969 **Roberto Gonzalez**
South Bend, IN

Does anyone know how to build a closed caption decoder? What kinds of chips, circuits, or component numbers should I buy to build it by myself? If possible, can you tell me where to buy the necessary components?

59610 **Tuan Pham**
Bellingham, WA

I have an IBM PS-2 (Model 8525) with 640 K RAM, 20 MB hard disk, and a BAD 720 KB floppy. The floppy cables differ from "Clone Standard."

I need floppy interfacing information so I can adapt my clone 720 KB floppy as a replacement.

59611 **G. Frank Humiston**
Santee, CA

I need to find out where I can get a driver for a three-button Logitech mouse model #C7-3F-HH, and a driver for an Irwin 8 mm tape driver model #445.

59612 **Anonymous**

I am trying to obtain a "processor" board for an AST computer model #500882-001. It is a Bravo 3/255-33MHz computer. The AST part number of this board is 202401-002. It fits AST motherboard number 202382. Used is okay, with or without CPU.

59613 **Delta-Tech Publishing, Inc.**
Saint Clair Shores, MI

I need a method of inserting the current time (and date if possible) into the composite video stream, being output from a CCD camera. I do not want to use microprocessors (PIC or 80XX

ICs) to accomplish this. I have been unable to locate any of the old ICs which could be used for this purpose, including MM58106, MM5841, MM5840, MM5318, MM53100, or MM53105. The composite video will be fed into a monitor, a VCR, and possibly a switcher which is part of a security system. Does anyone know of a way of doing this in a reasonably inexpensive way (no \$200-\$300 boxes)?

59614 **Robert M. Harkey**
Charlotte, NC

I have an HP 7550-Plus eight-pen plotter. Using Windows 3.11, I am able to print text and some limited graphics (boxes, lines, etc.), but I am wondering if it is possible to use this plotter to print color graphics, like PaintBrush files, BMPs, Gifs, or JPGs. I have visited HP's Website and FTP site and can find no help there. Any other ideas?

59615 **Kel Hess**
Mogadore, OH
KELHESS@EN.COM

I am trying to troubleshoot an Atari LYNX handheld video game with a color LCD that's packed with SMT components. Does anyone know where I can obtain schematics and parts sources? Is there a technical BBS/WWW site anywhere?

59616 **M. P. Slack**
Lake Forest, CA

I have a DFI model HS-3000 Macintosh hand scanner which I would like to modify for use with my IBM AT. I'm assuming the modification would involve replacing the current Mac mini eight-pin round connector with a nine-pin IBM serial connector. Any information regarding this modification, especially a pin correspondence chart, would be much appreciated.

59617 **John McMichael**
Laramie, WY

I have about 10 or so Zenith data systems 286 computers. The boot sectors are really strange — probably because the hard drives were magnetically wiped. I formatted the hard drive, installed MS-DOS 4.01 (any operating system will work right now), and rebooted the computer. After many unsuccessful attempts, it finally said Sector Not Found! You can do whatever you want with the hard drive except boot the computer on it. I fdisked it and everything. It just won't work!

59618 **Anonymous**

I am looking for assistance with information, drawings, or designs for a dynamometer to measure the performance of small engines (5 HP-18 HP) with speed, torque controls, and timed inputs to a computer. This information

ANSWER INFO

- Include the question number that appears directly below the question you are responding to.
- Payment of \$25.00 will be paid within four weeks of publication if your answer is printed.
- Only one answer per question will be printed.
- If you do not want your name, address, or phone number available to the reader please so indicate or it will be assumed that you have no objection.
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- No questions will be accepted that offer equipment for sale or equipment wanted to buy.
- Selected questions will be printed one time on a space available basis.
- Questions may be subject to editing.

HELPFUL HINTS

- Be brief but include all pertinent information. If no one knows what you're asking, you won't get any response (and we probably won't print it either).
- Write legibly (or type). If we can't read it, we'll throw it away.
- Include your Name, Address and Phone Number. Only your name will be published with the question, but we may need to contact you.

needs to be printable, allowing the comparisons between air velocity, RPMs, heat, and torque.

59619 **Chuck Francis**
Due West, SC

I have a number of eight-track cartridge recorders, eight-tracks like they used to use in the car that need new motors and belts. (The motors would have to be two-speed — the regular eight-track playback speed and the fast forward speed.) They are a Pioneer, a JVC, a Wollensak, and also a Radio Shack Portiplay, portable eight-track

player that needs a new belt. The one person in Redwood City who used to deal in eight-tracks doesn't want to work on or sell them any more. Does anyone know where I can get motors and belts for my decks? Does anyone know of any easy installation books or tips? (I'm a novice at installing.) Does anyone know where I can get sealed blank eight-track cartridges?

**59620 Paul Mendelowitz
Redwood City, CA**

What can I use as sensors at joints on a person's body moving about in a room-sized magnetic field to arrive at a wire frame image on a computer screen? I need a method to generate the magnetic field and a program to write or adapt.

**59621 Arthur D. Summers
Spokane, WA**

Is there a scanner available that inputs microfiche straight into a computer?

**59622 Richard Murray
Converse, TX**

Is there a way to use the DTMF receiver described in the April '96 *Nuts & Volts* with an old Apple IIc? These old computers are so cheap, they could be used as a continuous dedicated monitor.

**59623 Paul V. Engle
Citrus Heights, CA**

ANSWERS

ANSWER TO #49656 - APRIL 96

In looking for an outboard TV tuner for your Commodore RGB composite monitor, you might consider using an old VCR. Broken VCRs are readily available cheap or free from friends, neighbors, or swap meets. A friend recently picked up several to use as tuners for \$5.00 each at a hamfest. Usually the VCR mechanisms are broken, but the tuners work fine.

**Doug Smith
Roscoe, IL**

ANSWER TO #4967 - APRIL 96

It sounds as if you're trying to connect your back-up generator to your house wiring by making up a power cable with a male plug on each end, then plugging one end of the cable into the generator's output receptacle, and the other end of the cable into one of your house receptacles.

This is a bad idea for a couple of reasons. First, if someone pulls that cable out of your house socket while the generator is running, they've got a male AC plug with two hot prongs — a real shock/fire hazard! Second, if someone turns on your meter disconnect switch while that cable is plugged in, you may do some serious damage to the generator and/or your house wiring — again, a real hazard. Your electric company would probably be very distressed to see this practice. And if your house burns down and the insurance investigator finds this hook-up in place, they may refuse to pay on your policy, because you've created a hazard that is contrary to the National Electrical Code. So *don't do that any*

more!

Now, as to why it doesn't work. If your home has the usual wiring, the service coming in from the pole consists of two hot legs and a neutral wire. Voltage from either hot leg to neutral is 125 volts, voltage between the two hot legs is 250 volts. Roughly half of the 125-volt appliances on your house are connected to one of the hot legs; the other half are connected to the other. The hook-up you describe will feed voltage only to one of the two legs, so you *might* manage to successfully power some of your appliances that are on *that* leg. But you would *not* successfully power *any* appliances on the other leg, because the two legs aren't connected together. And, of course, you won't possibly power any of your 250-volt loads (electric water heater, electric range, etc.) because in order to operate, they need both legs simultaneously.

To come up with a solution, we need to make some assumptions. First, we have to assume that you are trying to power *only* some of the 125-volt appliances in your house; you *can't* practically power any of the 250-volt loads. Second, we have to assume that the total peak load you're trying to power is roughly 20 amps, since that's the output you've given for your generator (2500 watts/115 volts ~ 20 amps).

Ideally, you would go around your house, find all the outlets that you want connected to your back-up generator, and wire them all together on one circuit. This circuit should be wired with 12-gauge wire, since that's the gauge that the NEC specifies for a 20 amp circuit. Note, too, that in general, the *continuous* current on any circuit should not exceed 80% of the peak current; so the continuous total current to all your appliances should not exceed 15 amps (the rest is reserved for in-rush current when things are first turned on).

Now that you have one 12-gauge cable to power all your "emergency" loads, you should connect the "line" end of that cable to some sort of male connector. This can be a male two-prong plug, either dangling on the end of some flexible cordage, or one that comes constructed for mounting in a panel hole. In either case, this male connector should be located in close proximity to your back-up generator. Note that the *safety ground* (green) wire of your "emergency" circuit must *always* be connected to your electrical system's ground (from your electrical breaker panel). Okay, you have all your "emergency" loads ready to run; all you have to do is to plug this new male plug into some source of AC.

Now make a new 20 amp circuit from your existing home breaker panel. Run some 12-gauge wire from the panel to a new receptacle (female), which is also located near your generator. For normal operation, just plug your new male "emergency" connector into this receptacle, and you can run all your loads normally, through your house breaker panel. During a power outage, unplug this connector; then plug the male (which goes to your new load wiring) into your generator, and crank 'er up. This will power all of the loads plugged into your "emergency"

circuit without affecting any other wiring in your house.

Please note that some communities are *very* particular about who does electrical wiring; they may even require that you use an electrician who is licensed by the municipality! So keep in mind the legal and insurance considerations, in addition to just making it work. If you have *any* doubt about what you're doing (and forgive my saying so, but your question indicates that you really don't understand this at all), then have the work done by an electrician. Don't risk your property or your life just for the "thrill" of doing it yourself. My advice above is only general in nature, and I don't make any representations that if you follow this advice your results will be legal or safe. This is for instructional purposes only. I certainly can't assume any sort of liability for anything that you might do in my absence.

(As the Three Stooges used to say, "Don't try this at home.")

**Greg Miller
State College, PA
miller@ps.scan.psu.edu**

ANSWER TO #4969 - APRIL 1996

Check out my article "Lamp Dimmers and Creative Lighting Control" in the Feb. '96 issue of *Nuts & Volts*; it's just what you are looking for.

Jeff Mazur

ANSWER TO #49620 - APRIL 1996

The specifics on scan tool information for your GM car will vary greatly depending upon the year and model of your vehicle. GM made many, many changes over the years and incorporated many different baud rates for communication on the serial data line. The "language" for the software is not important since different scan tool makers have used different programming languages; what is important is the format, etc., of the data being sent to the scan tool and what they each represent, in terms of data values. Of course, this information is proprietary and is not available in the public domain. The scan tools makers (such as Snap-On/Balco, OTC, etc.) have paid the car manufacturers for the access to this information and for the right to have their scanners be able to read the data. Schematics for the ECM/PCM is probably available, but only in GM's engineering department, because again, like the rest of this system, it is proprietary information. Rather than trying to build a scanner yourself, it may be more economical to purchase a scan tool.

Gary Fuchikami

ANSWER TO #49618 - APRIL 1996

I have six pages of technical data on the National Semiconductor MA1012 Clock Module. It combines a monolithic MOS-LSI integrated clock circuit, four-digit 0.5-inch LED display, power supply, and other associated discrete components on a single printed circuit board to form a complete electronic clock movement. Add only a 50 or 60 Hz transformer and switches for a 12 or 24 hour display. There are 24 pin connections.

The six pages include general description, features, connection diagram, absolute maximum ratings, elec-

trical characteristics, optical characteristics, functional description, display modes, control functions, application diagram, and module schematic.

Contact me at 818-346-7024 9 am-5 pm Pacific Time so that I can forward this information to you.

**Fred Blechman
West Hills, CA**

ANSWER TO #49611 - APRIL 1996

I have a couple of suggestions for your color LCD video monitor.

First, there's the Sony XV-M30, a 3" color TFT active-matrix monitor, with a built-in speaker. It's supposed to take video line in, but make a call to be sure it has connectors that you can use. J & R advertises this for \$399.95.

Or there's the Panasonic PV-LCD35, a 3.2" color monitor with built-in speaker; J & R advertises this one for \$299.95.

Also, the JVC LT-V18U, with a 1.8" TFT active matrix color display, and built-in speaker. In fact, this one will run on 4 AA batteries, as well as the AC adapter. J & R has this one listed for \$99.95.

I know I've seen others, but I just happened to have the J & R catalog handy. Their phone is 1-800-221-8180. (No, I don't work for J & R.)

**Greg Miller
State College, PA
miller@ps.scan.psu.edu**

ANSWER TO #49650 - APRIL 1996

There are several conversion companies that can take your old Smith Corona word processor diskettes and convert them into the modern computer format of your choice. My favorite is Pivar Computing Services, 165 Arlington Heights Rd., Buffalo Grove, IL 60089, 708-459-6010.

**Doug Smith
Roscoe, IL 61073
dougs@mcs.com**

ANSWER TO #49663 - APRIL 1996

Data from the Hubble Space Telescope is transmitted to the earth in a format that is incompatible with TVRO dishes or weather satellite receivers. It would be very difficult, if not impossible for an amateur to intercept these signals directly from the Space Telescope. Astronomers who observe with the HST are allowed to keep their data private for one year from the date of observation to allow them time to publish their findings in scientific journals. After one year, the data becomes public property. If you have access to the Internet you can see the latest publicly released images at <http://www.stsci.edu/public.html>. Other HST related sites on the internet are at <http://quest.arc.nasa.gov/live/from/hst.html> and http://scivax.stsci.edu/~hamilton/nugget/s/hst_nuggets.html.

The Space Shuttle is also rather difficult to listen to directly. Most of the voice traffic between the shuttle and mission control is carried by encrypted digital voice links using the Tracking and Data Relay Satellite. There is an amplitude modulated voice channel on 259.700 MHz which is usually used only during launches and landings. If the shuttle passes near your location on its way to a landing, you might be

Continued on page 118

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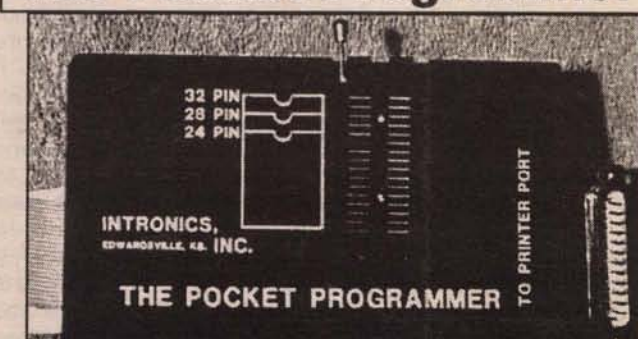
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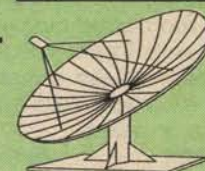
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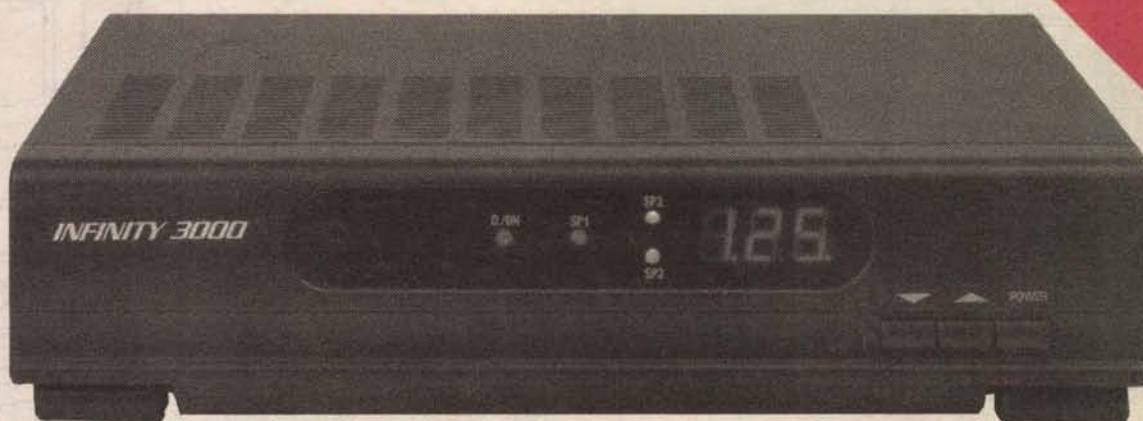
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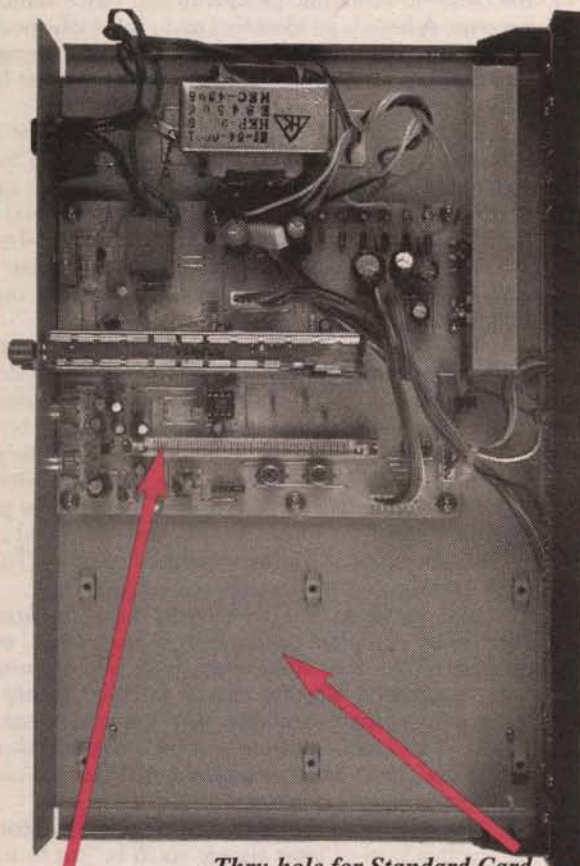
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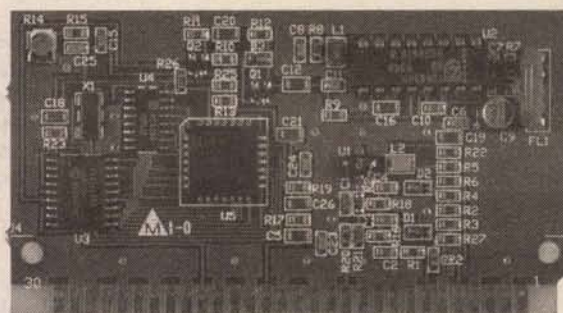
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Conducted by
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Welcome! This month, we'll look at some possible future use in space for lasers. Lasers can be used for communication purposes, as we have noted before in these columns. But what about extremely long-distance communication and even peaceful spacecraft maneuvering possibilities?

One such communication arrangement we mentioned here before is the retroreflector left on the moon by the Apollo 11 mission. In this case, a high-powered pulsed laser is fired from the earth and the return signal analyzed as to the time it takes for the transit period. Thus, scientists can get a precise reading of the earth-moon distance, down to a few meters in accuracy. One classifies this as instrumental use, or crude communication.

Some people have wondered how a laser might fare as a communication device to say, a space station. NASA is planning to implement a Space Shuttle laser data communication system, and perhaps they already have. I first heard of this from their publication *NASA Tech Briefs* a couple of years ago. A communication device from shuttle-to-space station, or from earth to either, is certainly not science fiction.

An internationally co-operative space station is planned to be placed in Low Earth Orbit, or LEO. At just a few hundred miles above the earth, and after the turn of this century. Further distances than LEO are possible of course, but the expense of using extra fuel to get out there would be proportionately greater. Most of the propellant usage is accomplished to get the construction parts and ultimately the incoming rendezvous spacecraft out of the majority of influence from earth's gravity. Falling back to earth is the easy part for rendezvous spacecraft.

Obviously transit time would be increased by further distances. The fuel problem is why missions to other planets, currently conducted with robotic spacecraft, are calculated with extreme precision, and utilize a neat gravitational trick. Those missions take advantage of the gravity fields of the planets (or the sun) available at the trajectory line-up at a pre-determined period of time. Thus in order to "slingshot" the spacecraft towards its intended destination, and of course saving much fuel. Such trajectories are breathtakingly beautiful in their precision; the Voyager spacecrafts have used several physics-orchestrated planetary gravitational boosts in their successful quest to give us the most photographically dramatic views ever of the outer planets of our solar system. Not in the least, the greatest wealth of scientific data about those planets ever achieved thus far in the history of humankind.

Let's Look at a Space Station!

Space stations in LEO, or for that matter further distanced, could receive extremely high speed communications from a base here on the earth, or even the moon, by virtue of the immense data-carrying capabilities of laser beams. Higher and higher radio frequencies are proliferating down on our planet, as we speak. These high-frequency radio signals are for such diverse uses like cellular phones, military communications, and space communications. The laser, because of its exceedingly high

frequencies, can theoretically transmit one million to a billion times more data transmission speed than the highest radio frequency rates we now accomplish with RF. That depends upon the wavelength of the laser; the shorter, the faster.

Although the laser data transmission rate is currently not fully developed, one does not see why it could not be greatly improved in the near future. New advances in the operating speed of semiconductors are critical to the expansion of data-carrying ability. Since no matter how high the frequency of the laser lightwave, you still have to employ the most rapid speed possible of its modulation devices in order to fully impress that laser lightbeam with its intended data.

Space Object Ballistic Parameters

How do you communicate with a space object that circumnavigates about the earth several times in a day? For example: the Space Shuttle (and everything else in LEO) gets several sunrises and sunsets in a single day due to the fact they are just a few hundred miles up in space. Romantic, eh? As does the space station Mir, which we've all heard a lot about lately. This presents an interesting scenario. A space object can be rocketed into a GEOSYNCHRONOUS orbit, 22,300 miles out. This, I understand, was first proposed by Willy Ley in his 1957 book *Rockets, Missiles, and Space Travel*. However, for an object as large as a space station, that isn't practical.

To explain further, what a 22,300 mile distance achieves is this: Like many satellites now stationary amongst the heavens, a geosynchronous orbit enables a stable, remaining position above the earth for any object in space. Fiction? No, otherwise your satellite TV wouldn't work; you'd constantly have to adjust the position of your receiver dish and your selected satellite would disappear over the horizon several times per day. Annoying, for sure.

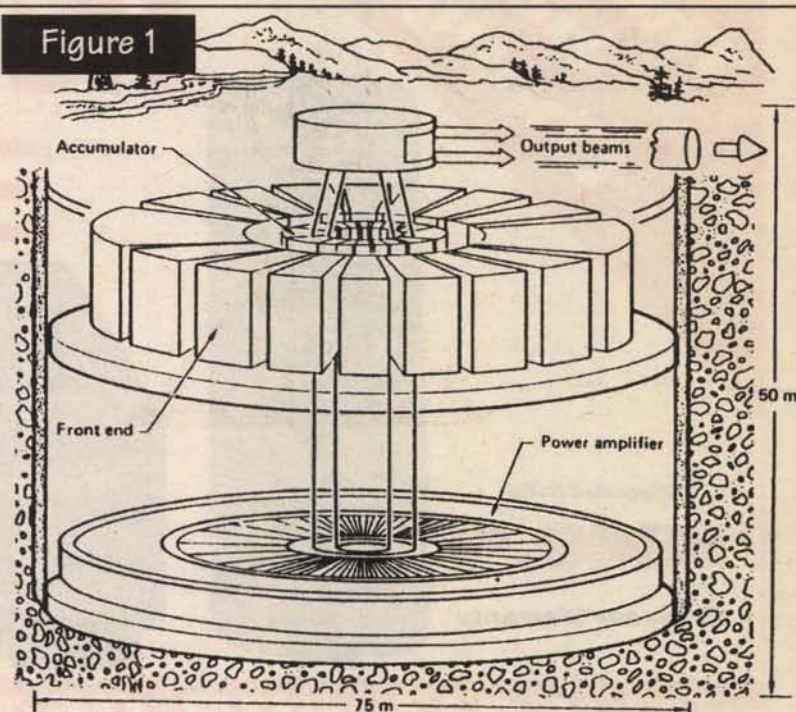
Consider now a space station at just a fraction of the geosynch orbit. In order to communicate with the station, several radio transmitters and receivers have to be located about the planet, so when one goes into planetary horizon radio shadow, the next can take over. With some loss or, chance of loss, of data integrity to be expected at each transition.

Laser Data Transmission from Earth

What I'm thinking about is the probable development of data transmission that needs to be accomplished in the future. If a space station(s) becomes a viable economic reality, and if they really do happen, the benefits to us on earth may be very lucrative and enlightening. However, remember the Super Conducting Supercollider was cancelled. Social programs seem to be the economic priority of the day, superceding mind-expanding fundamental discoveries of our universe. (Despite various social programs' obvious lack of efficiency at this juncture.)

The manufacturing of integrated circuits, chemicals, metals, biomedical supplies, and living cultures aboard a space station(s) will likely require constant real-time data

Figure 1



Krypton Florida Laser Beam Weapon

This mockup of a design for a 2-megajoule krypton fluoride laser beam weapon system is from a June 1981 report of the Los Alamos National Laboratory. The system would be buried in the ground and would have a pop-up turret for shooting the beam.

updating. The more efficient all processes can be made, the closer to economic prosperity any space station will become. A laser is an ideal tool to do this high-speed and economical data transfer, because the synchronism of radio signals to earth-based telemetry might just be too slow!

Consider a laser beam, operating at perhaps a million times faster than the best radio-based data transfer systems now in existence. Sound odd? Not really, my outdated desktop computer now runs several hundred times faster than the one I built in the early '80s, and there are state-of-the-art machines 50 times plus faster than mine! This one example appears to be the norm of ongoing progress.

Thus, data can be exchanged between the earth and between any space vehicle at a phenomenal rate. The development of PCT, or Phase-Conjugate Technology (see LEMar95 and LEApr95), enables a laser beam to automatically lock on to a space vehicle. What would be needed is a reflective surface on the receiving vehicle for a probe beam to latch onto initially. Then a more powerful data transmission beam would commence, and atmospheric distortions would be minimized using PCT until a valid data signal is successfully exchanged.

And certainly the technology spin-offs from the "Star Wars" program of the Reagan presidential era are capable of this feat. Remember, that program was seriously suggesting blasting enemy satellites to bits from down here on earth, and there were some impressive test results. That technology, once it becomes fully de-classified to our countrymen, is ideally suited for data communication to objects in space.

Consider now the idea that a powerful, but non-destructive level of laser energy could be put to use. To illustrate this point, Figure 1 is a sketch of an infrared laser beam weapon proposed in the '80s. The power of this hypothetical weapon is no less than phenomenal. Using a chemical pumping system for the laser, it generates laser pulses of two million watts each. Far more

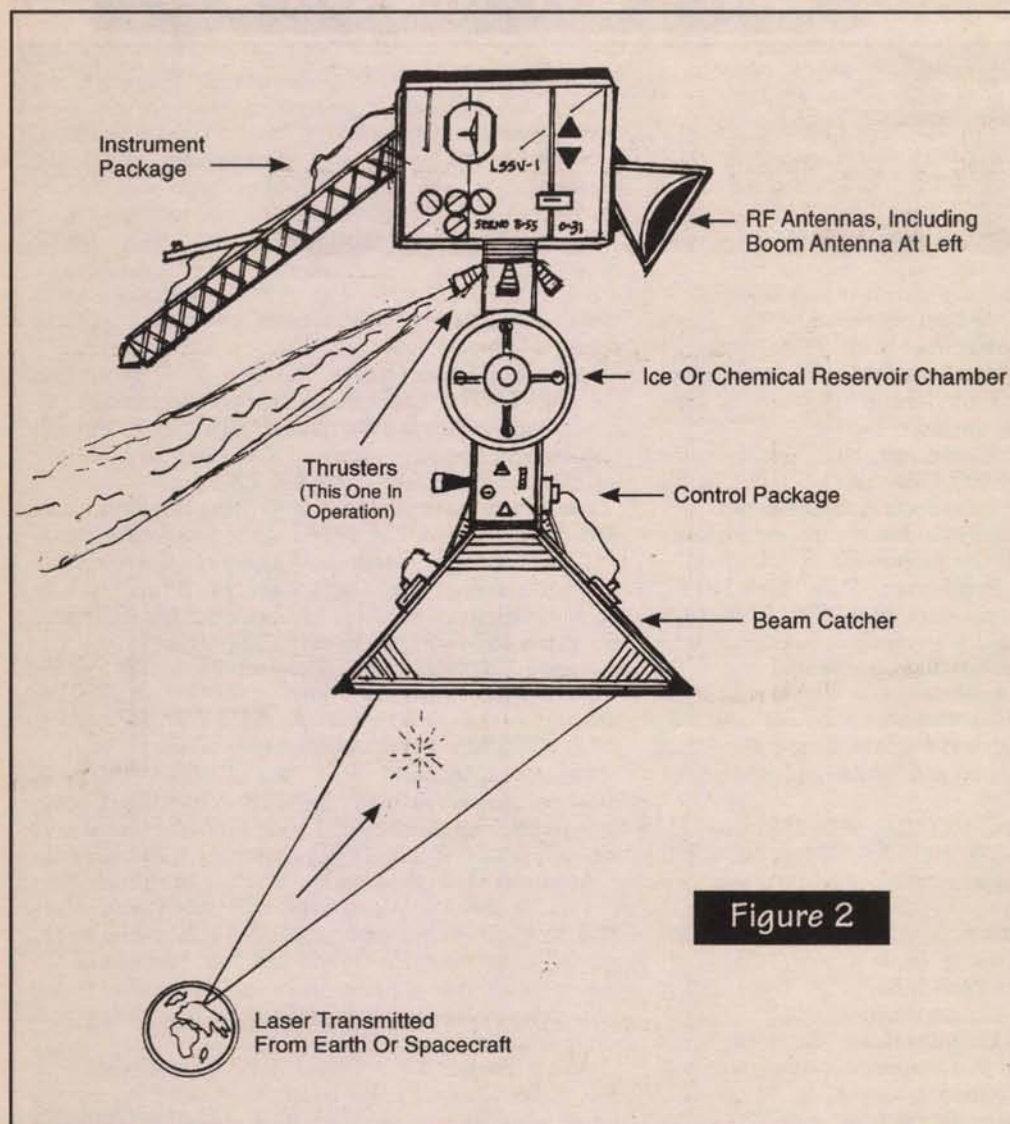


Figure 2

power than is required for effective data transfer and far more than is needed for the following proposal, which is a ground-based (or space-based) satellite positioning system.

A Hypothetical Satellite Positioning System

Figure 2 shows a possible use for orbit adjustment of satellites from an earth-based laser. We all know spacecraft burn hydrogen and oxygen which combine to produce water, lots of heat, and plenty of thrust. Many space vehicles are launched with this chemical propellant com-

Here's the point: Satellites have to carry on-board chemical fuels to correct their orbits from time-to-time. Orbital decay of satellites is a fact of life. It is due to the pull of the earth's gravity (even in supposedly gravity-free space) and minuscule friction with residual components of the atmosphere. This necessitates the periodic orbit corrections of any space vehicle. Question: What if we employed "Star Wars" laser technology to adjust a satellite's orbit instead of carrying complicated fuel systems and bulky fuel storage tanks on board it? It would make an interesting proposition to have a satellite carry the following cargo (besides its payload) when it's launched:

- Instead of cryogenic tanks and all the associated control equipment, a cargo of frozen water pellets.

A laser, based either on the earth or at a space station, would vaporize the on-board water pellets, turning them into extremely high-pressure, very high temperature steam, for use as maneuvering mass when orbital corrections are required. Or for the process of boosting the satellite out of orbital decay, or to reposition

it to a higher orbit.

Absorptive material aboard the satellite would select the correct laser wavelength, to the exclusion of others. Thus, a potential enemy wouldn't be able to access your satellite without knowing the optical "code" of your particular spacecraft, and laser energy would be sent to the right satellite, at the right time. Much like your cordless phone won't likely broadcast conversations to the neighbors, because now they have privacy channel codes.

Again, Figure 2 shows a model satellite whose laser heat-catcher is positioned to receive the laser beam. The laser catcher might employ several means to absorb and store the energy for a short period of time until it's ready to accomplish the maneuver. One such means is to heat a liquid metal, like ordinary solder or sodium metal or perhaps mercury, and store that in a cylinder. That superheated metal could then be used to vaporize the ice pellets, which would be injected beforehand by a mechanical mechanism into a propellant chamber as needed, to generate thrust. The metal would be recirculated and saved in a storage vessel to be used again and again. Another possibility is to use the laser to heat a thermopile, essentially a stack of thermocouples. Electrical energy generated by same could be stored in a battery or a bank of low-leakage, high-voltage capacitors.

Capacitors raise a fascinating propulsion possibility because laboratory demonstrations have already proved the possibility of stored energy pulsed discharge propulsion. (I did one demo myself, but at home.) By discharging a powerful burst of energy through water, it vaporizes it, and the superheated steam can be used as a propulsive medium if ejected through the right nozzle. It's basically not too much different than when a lightning strike hits a tree, the tree's sap boils instantly with enough force to split and, perhaps, topple the tree. The difference is proper direction of the force via the nozzle.

Sheathing the satellite in reflective material would prevent it from heating up from the laser. As we said, absorptive material would soak up the laser energy like a sponge. And by choosing the right wavelength and collimating lensing systems, the beam would not lose much strength propagating through the atmosphere, and virtually nothing if the beam propagates through space.

Techniques and materials have been developed already for this idea; one idea I heard of is to actually propel a spacecraft into orbit using ground-based high-powered lasers and ice (or another material) as a vaporizable propellant. If this all sounds too sci-fi, consider that there is a research program I've read about whose goal is to electromagnetically launch small projectiles directly into LEO, without any propellant at all! Their chief problems at this point are developing projectiles whose on-board equipment is capable of withstanding the high acceleration G-forces encountered. Plus the fact a material must be developed or modified to withstand the tremendous heat the projectile will experience in the lower, denser part of the earth's atmosphere at this maximum mechanical and thermal stress period of the launch phase.

Physically accessing remote objects in space is certainly nothing new, NASA has faced this challenge with every docking maneuver ever done. One of the most interesting PROPOSED remote space accesses is shown in Figure 3. Here we see a giant catch-bag in space, made of the same super plastic used in law enforcement bulletproof vests. Its purpose, according to the ideas proposed by its inventor, is to catch parcels of lunar soil (regolith) ejected by a magnetic mass-driver located at a colony on the moon. Gravitation and precise ballistic mathematics would play the key role in determining whether or not the parcels would arrive at the trajectory of the bag, miss it, or perhaps rip one giant hole in it.

Laser Helpline

This is a free service to the readers of The Laser Experimenter who wish to get in touch with one another by whichever medium they mutually prefer. To place your "free ad" (no commercial products, please), send your abstract and communication protocol to: The Laser Experimenter, Laser Helpline, P.O. Box 74, Cornwall Bridge, CT 06754.

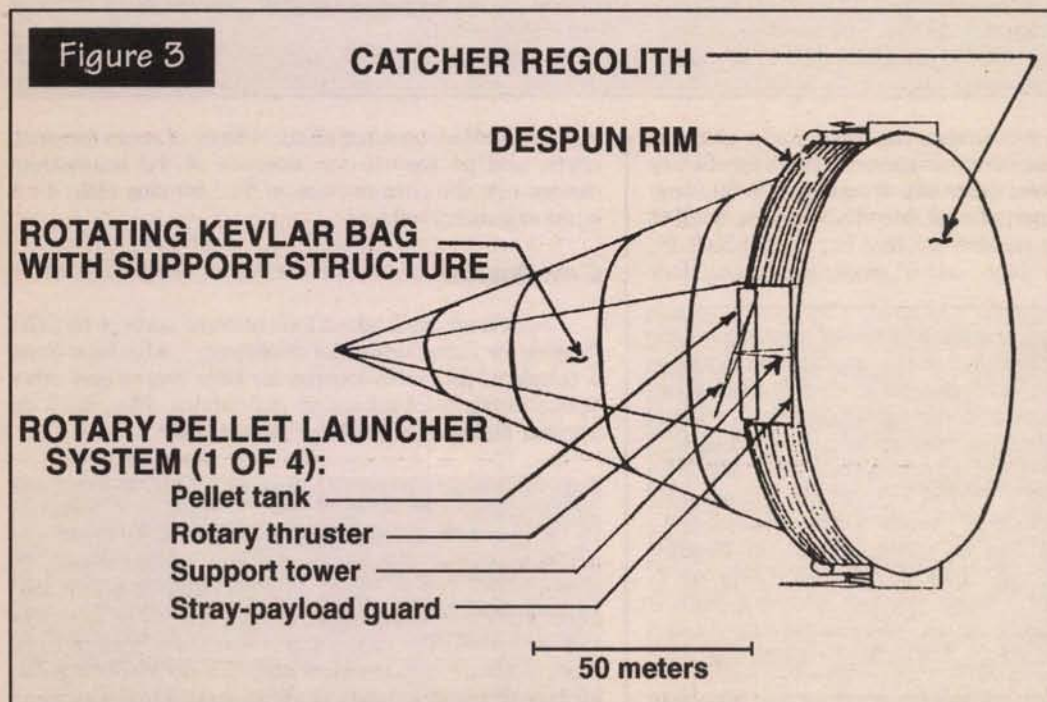


Figure 3

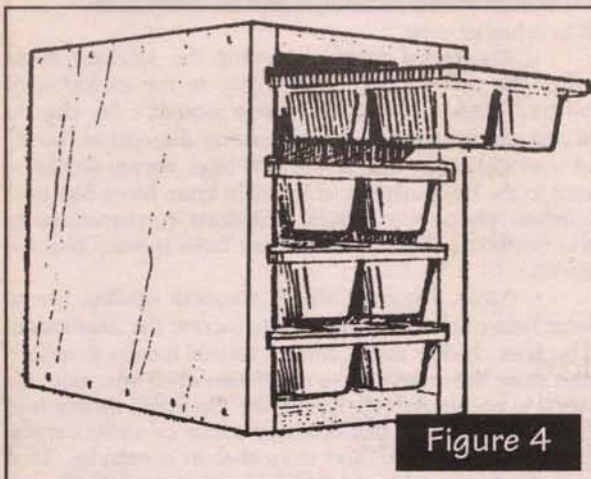


Figure 4

The latter possibility would be antithetical to the "... one giant leap for mankind" statement made by Neil Armstrong, when he put the first human footprint ever on the moon.

One can surely see the potential for a LIDAR (laser-radar) safety guidance system for this and other space-based structures, and even those little bags (which probably could weigh a significant fraction of a ton here in the 1-G gravity environment of earth) might be laser-assisted by active positioning systems. Once full, the catch-bag would be maneuvered from a lunar orbit to a space-based processing facility which would convert the lunar soil into metal and bulk un-refined radiation shielding for a large space station.

Note the pellet launchers about the bag. Their ejected mass imparts a slow spin to the bag for stability. A laser-based remote propulsion system would be a fantastic addition. There is plenty of power available from the sun that could be generated by photovoltaic cells to run such a laser. And even if its contents weighed a million tons in a 1-G environment, multiple catcher bags could share the burden and enable on-time arrival at a processing facility(s), once the cycle of fill-and-deliver was operating at a regular rate.

Far-thinkers have proposed the exciting possibility that self-sufficient colonies could be established in space, much like the earth-based Biosphere II. This is an interesting idea, and although the technology may be a century or more in our future, the actual development of a space colony would add greatly to the human experience, our place in this universe, and our understanding of how to increase the quality and individual value of our lives in ways one cannot fully foresee.

Sometimes one becomes cynical about far-thinkers, perhaps especially if they think about space. However, consider in the span of a lucky individual's long lifetime we have progressed from the first flight ever in human history, built by two brothers who ran a bicycle shop, to putting space stations up there. And visiting our planets and their moons distanced up to billions of miles from our home. And don't forget placing our equipment (and footprints), in person, on our moon 238,000 miles away.

An Organizational Tip

Hmm ... back to earth. Quite a re-entry. Two tips on organization. One is the little ice-cube tray stack shown in Figure 4. This is a real inexpensive way to organize parts. The wood sides can be routed, as shown in the figure, or small strips of wood can be glued to the sides, so either way the trays slide in and out freely. Any number of trays can be used, and of course they can be stacked on one another or placed side-by-side in a tandem arrangement to house all your parts.

I think I have about 400 separate little drawers for

Closing Quote:

"The earth is the cradle of mankind, but one does not live in the cradle forever."

— Konstantin Eduardovich Tsiolkovsky,
Russian space pioneer who made fundamental
contributions to Astronautics.

SOURCES

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Geo-Monitor, 65 Washington Street, #400, Santa Clara, CA 95050; ph: (408) 749-6770, FAX: (408) 249-3780. Publishes a technical newsletter about earth science, and may be useful to those interested in using lasers to record seismic activity.

Edmund Scientific Company, 101 East Gloucester Pike, Barrington, NJ 08007-1380; ph: (609) 573-6250, FAX: (609) 573-6295. Free catalog. Supplier of a wide variety of educational and scientific equipment including lasers and an extremely comprehensive line of optics.

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Imaging Concepts Bulletin Board Service. A free scientific bulletin board that contains, among other topics, laser information. Georgia area code. Parameters: 9600 baud, N81. Accessable 24 hours a day by calling (404) 466-3932.

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The Electronic Goldmine, P.O. Box 5408, Scottsdale, AZ 85261. Free catalog. Ph: (602) 451-7454, FAX: (602) 451-9495. SMC components and a wealth of high-tech experimenter electronics, components, and project kits.

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Anderson Lasers, Inc., 2883 West Royalton Road, Broadview Heights, OH 44147. New and surplus industrial and scientific lasers & equipment. Carries high-power commercial grade equipment, not a hobbyist supplier. Professional inquiries contact: Richard Anderson, ph: (216) 237-6629, FAX: (216) 237-0656.

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Images Company, P.O. Box 140742, Dept. N, Staten Island, NY 10314; ph: (718) 698-8305. Carries holography supplies, optical components, components for laser power supplies, stepper motors, CCD camera.

Amateur TV Quarterly, 1545 Lee Street, Des Plaines, IL 60018; Voice: (708) 298-2269, FAX: (708) 803-8994. Publisher of a magazine and several books geared to amateur TV. Mentioned here because of the general interest to experimenters and the parallel to our laser video endeavor. Contact them for the current pricing of a sample issue and brochure.

Small Parts, Inc., 13980 N.W. 58th Court, P.O. Box 4650, Miami, FL 33014-0650. A valuable resource for construction materials, tools, and hard-to-find items such as telescoping tubing, sheet metal, metric hardware, etc. Free catalog. Catalog requests: (305) 558-1255.

LNS Technologies, 20993 Foothill Blvd., Suite 307, Hayward, CA 94541; Inquiries: (510) 886-9296, orders: (800) 886-7150. Visible laser diodes and a driver kit, also carries a line of high-technology electronic kits. Accepts major credit cards. Catalog \$1.00.

Marlin P. Jones & Associates, Inc., P.O. Box 12685, Lake Park, FL 33403-0685; ph: (407) 848-8236, FAX: (800)-4 FAX YES. Carries some surplus He-Ne and diode lasers, power supply kits, and surplus optics. High voltage wire. Many interesting electronic items both new and surplus. Free catalog.

Be sure and mention Nuts & Volts when you contact the above suppliers so your request goes to the right department.

parts. Electronics proliferates the need for a place to house them! One supplier that currently has a terrific buy on a 30-compartment parts bin, if you want to buy one, is Parts Express International, Inc. Their phone is (800) 338-0531 and the number for that bin is 360-355. It's about 11" wide, 8" high, and 5" thick, and a nice black

color in molded, textured plastic. Plenty of room for small parts, and all easy to see because of the transparent drawers. At the current price of \$12.50 plus s&h, it's a good organizational tool.

Conclusion

Next time, we'll take a look at some surveys by SETI (Search for Extra Terrestrial Intelligence), who have done a couple of programs looking for laser beams and other optical artifacts of advanced civilizations. Plus, we'll do another build-it-yourself laser project. **NV**

Anthony Charlton is an active electronics and science "do-it-yourself" project designer, does custom R & D, and writes technical articles. Previous work experiences include design of hardware & software for microprocessor-based process control systems and electronic design. His hobbies include lasers, gardening, target shooting, model rocketry, and radio-controlled model airplanes.

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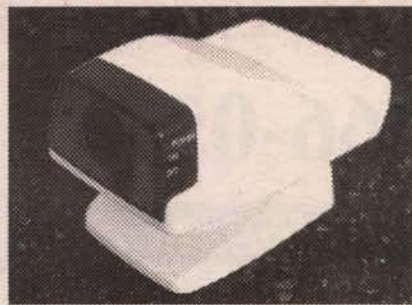
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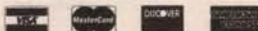


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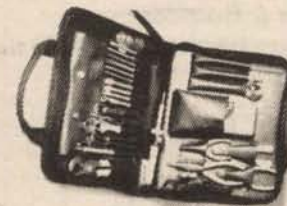
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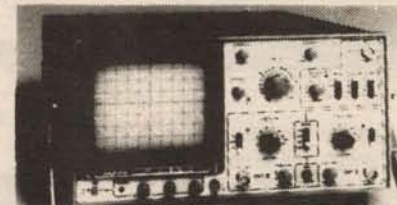
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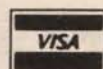


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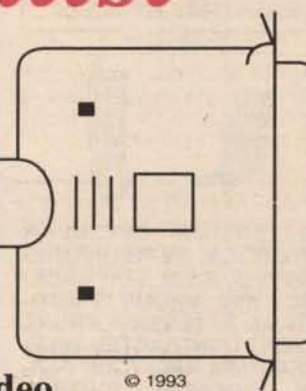
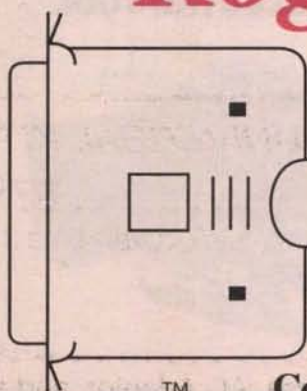
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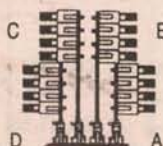


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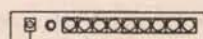
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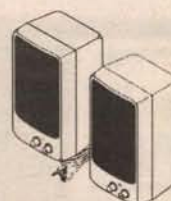
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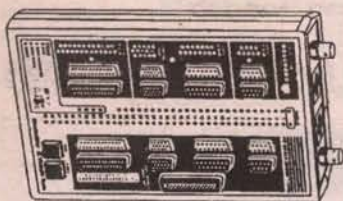
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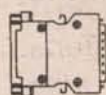
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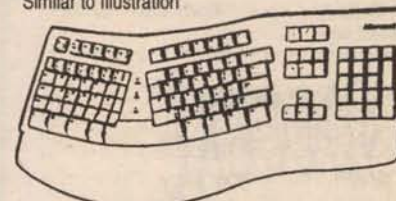
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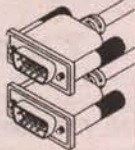
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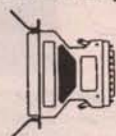
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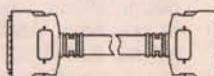


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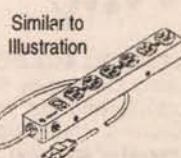
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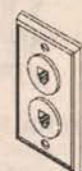
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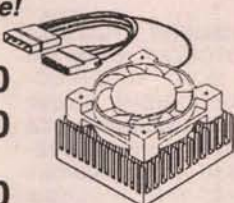


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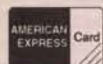
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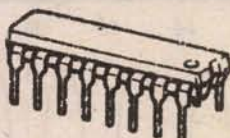
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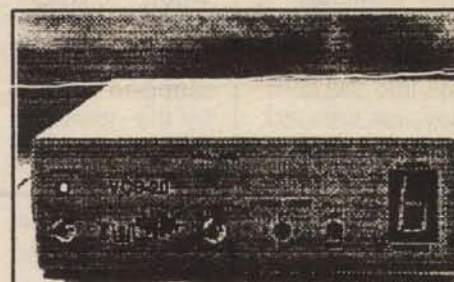
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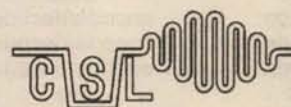
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Talking With MIME

You've listened to the hype and heard the promises, and finally decided to take the World Wide Web plunge and join the rest of the Web surfers. With visions of filling the cyberspace with insightful epistles and creative software, you set out to conquer the world — only to be thwarted at your first attempt to send a graphics image to your friend in Peoria. So what's the problem? Did you select a bum on-line service?

No, instead it has to do with the way the Internet delivers mail. Although the Internet has only recently come to the attention of the general public, it's been around a long time and is built on a 30-year-old technology — a technology that can't deal with binary files, like the kind used to send software programs and images over phone wires.

Surviving in a Text-Based World

In the early days of computing, most systems were stand-alone mainframes that connected to the outside world through terminals. A terminal is a video screen with an attached keyboard, which the operator used to enter data into the computer. Whenever a key was pressed, the keyboard generated a code —

an ASCII code that's still in use today — which uniquely identifies the key pressed. As the world grew smaller, and mainframes were linked together, it was only logical to go with a proven technology and use the ASCII code that was firmly entrenched in computer communications. However, some precautions were needed to make the systems work together.

In addition to the alphanumeric typewriter keys, there are several special-purpose keys, like Esc and Enter, that are used to control the computer. To prevent these commands from going across the link and interfering with the other computers on the network, the code of these keys is purposely filtered out. When the Internet was crafted, it too, adopted the same strategy.

However, this limits the transfer of data through the Internet to plain text files only. This restriction is in direct conflict with binary files, which use the control characters to encode data; when these control characters are stripped away by the gateway, the binary file

simply falls apart.

Plain Text Encoding

The key to moving binary files through the Internet is to encode the file into plain text using unique character combinations to replace the special characters found in the binary file (Figure 1). The converted file is then sent over the Internet, and the received

The key to moving binary files through the Internet is to encode the file into plain text using unique character combinations to replace the special characters found in the binary file.

Are you having trouble sending graphics images and application programs through the Internet? Let one of these MIME programs help you breach that barrier.

ASCII file is converted back to its original state using a decoder.

Over the years several plain text encoding schemes have appeared — and disappeared. One reason for the high mortality rate is that both the sender and recipient have to agree on the same method. This is in a world where it's hard for people to agree on anything, especially

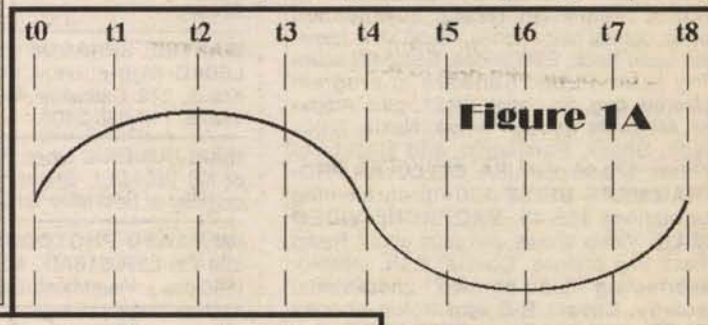


Figure 1A

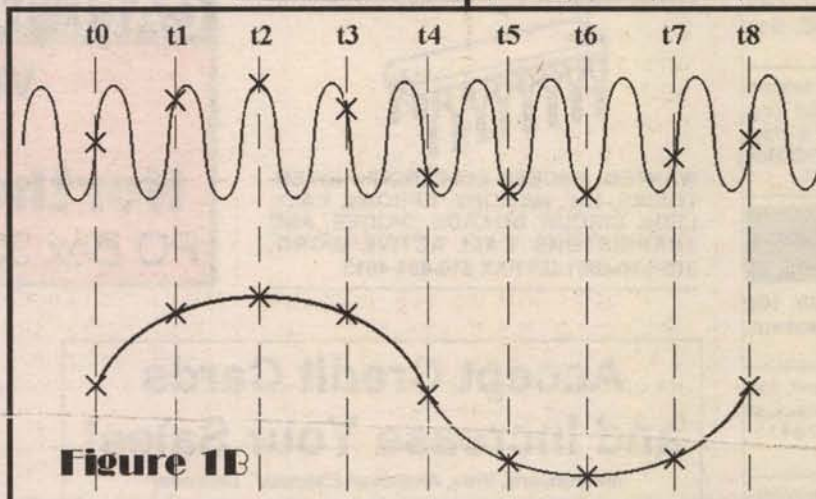


Figure 1B

computers. Currently there are three different methods in popular use.

UUcoding is historically credited with being the first plain text encoder, and is commonly found on Internet NewsGroups in which users wish to exchange binary data through a public forum. Unfortunately, UUcode's rather simple encoding method uses the space character in its encoding, a character that some mail

gateways strip from the file when it falls at the end of a line. In later versions of UUcode, a special case situation is added to the encoding algorithm to avoid the problem, but the encoded files are now incompatible with the older version. The related files are UUEncode and UUDecode.

XXcoding is a rarely-used method that's just one of many attempts at fixing the problems encountered in UUcode. Unfortunately, it uses a character set that's not available on some machines. Its related programs are XXEncode and XXDecode.

MIME: The People's Choice

The most robust and most popular plain-text encoding standard is

TABLE 1

	ESS-Code	ESS-Code for Windows	InterCode	MIME64	MPACK MUNPACK
Price	\$15	\$15	\$28	freeware	freeware
Platform	DOS	WIN	WIN	DOS	DOS
MIME support	encode/decode	encode/decode	encode/decode	encode/decode	encode/decode
UU support	encode/decode	encode/decode	encode/decode	no	decode
XX support	no	no	encode/decode	no	no
Binhex support	no	no	decode	no	no
Drag & drop	n/a	yes	yes	n/a	n/a
Batch process	no	no	yes	no	no
Auto split/comb	no	yes/yes	yes/yes	no/no	yes/yes
File name	ecdos.zip	ecd67win.zip	icode300.zip	mime64b.zip	mpack15d.zip
	UUDecoder	UUDeview	UUDeview for Windows	Wincode	Xferpro
Price	\$18	freeware	freeware	freeware	\$10
Platform	DOS	DOS	WIN	WIN	WIN
MIME support	decode	encode/decode	encode/decode	encode/decode	encode/decode
UU support	decode	encode/decode	encode/decode	encode/decode	encode/decode
XX support	decode	encode/decode	encode/decode	encode/decode	encode/decode
Binhex support	no	no	no	encode/decode	encode/decode
Drag & drop	n/a	n/a	yes	w/Winsock	yes
Batch process	yes	yes	yes	w/Winsock	yes
Auto split/comb	na/yes	yes/no	yes/yes	no/yes	no/yes
File name	uud273.zip	uudvd04.zip	uudvw04h.zip	wncod270.zip	xferp110.zip

MIME (Multipurpose Internet Mail Extensions). Sometimes referred to as the Base64 method, the MIME standard lets you encode a wide range of different file formats, including enriched text, PostScript, images, sounds, compressed files, and much more. Unlike UUcoding, which comes in several different flavors and formats, MIME is a sanctioned standard that works the same for everybody.

MIME is mostly used by individuals having an on-line account, like America Online or CompuServe, who want to send binary files via E-Mail. For example, let's say you have an AOL account, and you wish to send a program to a buddy who's on CompuServe. You first encode the program with a MIME encoder, like one of the several mentioned later in this article. Then you script a short opening message, attach the encoded file to the message, and mail it to your friend at CompuServe. When he receives the message, he simply downloads the file and restores it using a MIME decoder.

Split Files

Before you crank up your modem, though, there's one more factor for you to consider. At each end of any modem link is a communications program. In the old days, we used software like Kermit or ProCom Plus. Today, we normally use the software supplied by the on-line service, or buy an E-Mail package like Endora.

To prevent data dropout when

receiving a file, many communications programs hold the incoming data in buffers. If the incoming file is larger than the recipient's buffer size, parts of the file may be truncated (lopped off). To keep this from happening, large files are often broken up into smaller files and sent separately, one after another.

The buffer size varies from program to program, and many programs have a variable-size buffer that expands as needed.

If you are having problems sending big files, try limiting the size of your MIME files to 1,000 lines — about 64K. Many times, the MIME software will automatically make the

splits for you, and collate the files with file names like FILE1.M01, FILE.M02, FILE1.M03, etc. Sometimes you have to do the splits and conversions yourself by hand.

Shopping for a MIME Converter

To help you find a MIME convert-

readily available.

What we found were five shareware programs that sell for \$28.00 or less, and five that are free for the asking. Half are DOS-based, half are Windows-based. Five of the programs can batch process more than one file at a time, and four can encode and decode split files. Several of the converters also encode and/or decode UU and XX files in addition to MIME.

The program list in Table 1 is by no means comprehensive. I'm sure there are programs we missed, and those that we dismissed. MIME converters can also be found in some E-Mail programs, like Endora. Most of these converters are available on the Internet at http://www.cyf-kr.edu.pl/ftp/simwin/simtel_encode.html — or you can download them from our *Nuts & Volts* Web site at <http://www.nuts-volts.com>

Break the Silence, Get MIME

Now that the Internet genie is out of the bottle, there's no way to prevent it from growing ever larger. And it's highly unlikely Internet will be revamped to accommodate binary files — there's just too much invested in hard-

ware and software for that to happen. Fortunately, we have MIME. **NV**

MIME Glossary

Every technology has its own list of buzzwords used by the in-crowd to keep the rest of us guessing. Here's a quick lesson in networking computerese that should bring you up to speed with the network nerds.

BinHex is a popular encoding algorithm, used mainly on Apple Macintosh computers, that uses Run-Length Encoding (RLE).

Body is the part of a message immediately after the header.

Content is the message portion of a MIME message.

ESMTP, an acronym for Extended Simple Mail Transport Protocol (see SMTP), described in RFC 1651. Seldom used outside the Unix community.

ftp is the file download forum of the Internet.

Gateway. A gateway is an electronic repeater device that intercepts and steers electrical signals from one site to another. Generally, the gateway includes a signal conditioner which filters out unwanted noise and control characters.

GIF is an image compression standard invented by CompuServe for the interchange of graphics images over its on-line service.

Header lists the To, From, and Subject matter at the start of a message.

HTML, an acronym for Hypertext Markup Language, is the file format commonly used to create World Wide Web (WWW) screens. It isn't compatible with MIME or UUd formats, and can't be used to exchange binary files.

JPEG is an image compression standard for still images.

Mail server is the "post office" of a messaging network.

MIME, an acronym for Multipurpose Internet Mail Extensions, is a method for encoding binary files into ASCII characters for transfer across the Internet and on-line services.

MPEG is an image compression standard for moving pictures.

MUA, an acronym for Mail User Agent, is the end user's mail program, like Endora, ELM, /bin/mail, etc.

PEM, an acronym for Privacy Enhanced Mail, is a blanket description of protocols, like PGP, that attempts to add security to MIME messages.

PostScript is a popular format used to create World Wide Web screens and send documents over the Internet.

RLE, an acronym for Run-Length Encoding, is a lossless compression algorithm used in the Binhex version of MIME, commonly used by Apple Macintosh computers.

SMTP, an acronym for Simple Mail Transport Protocol, is a mail server protocol described in RFC 821 that's commonly used with Unix and Apple Macintosh systems.

Text/enriched, the successor to MS-DOS text/richedit, is a simple text markup language for MIME that lets you markup the document (using commands enclosed in angle brackets) without making the text unreadable to someone without the software to interpret it.

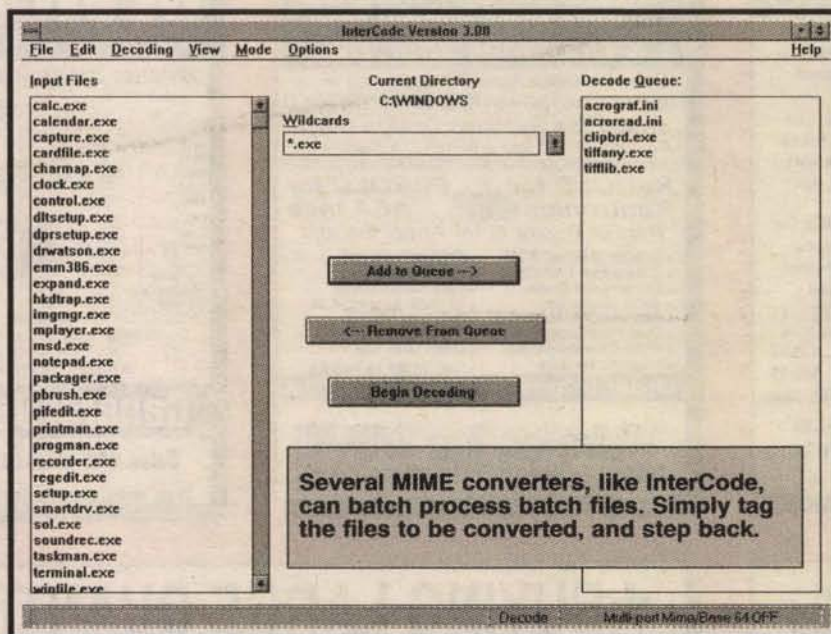
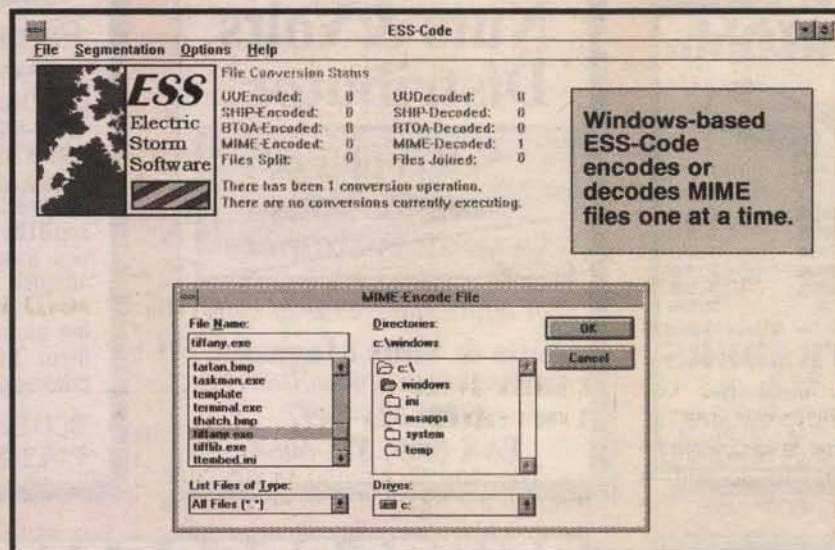
Text/simplemail is another text markup language used to embed format commands into MIME text files.

URL, an acronym for Uniform Resource Locator, is a shorthand way of expressing an Internet address, like <http://host/path>.

UUD, short for UUDecode, is a software utility used to decode UUEncoded files.

UUE, short for UUEncode, is a de facto encoding protocol used, mostly by the Unix community, to transfer binary files across the Internet and on-line services.

WWW is an acronym for the Internet area called the World Wide Web.



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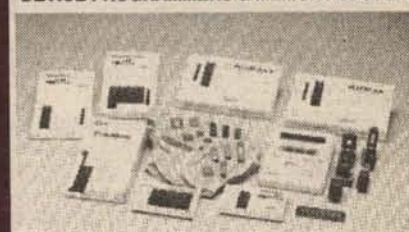
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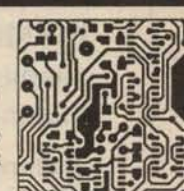
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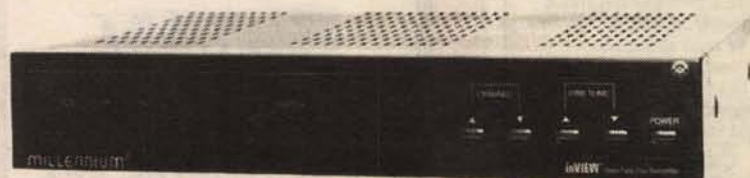
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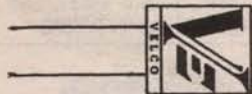
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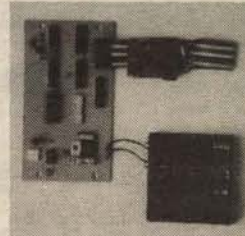
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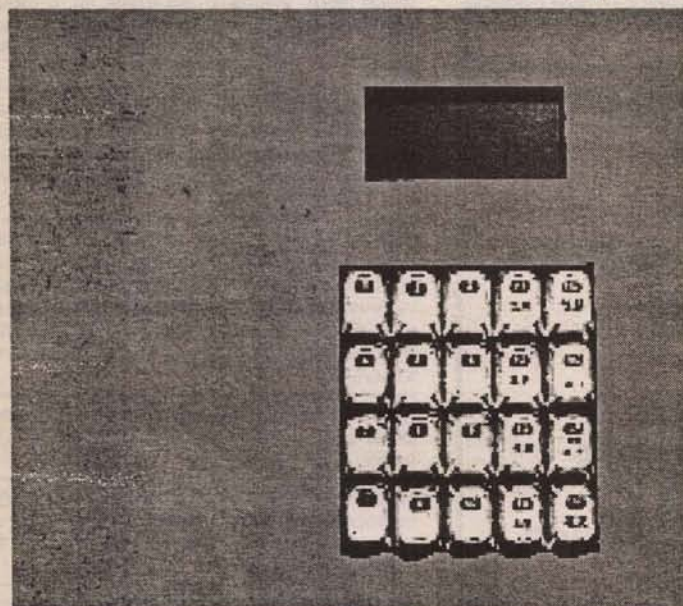
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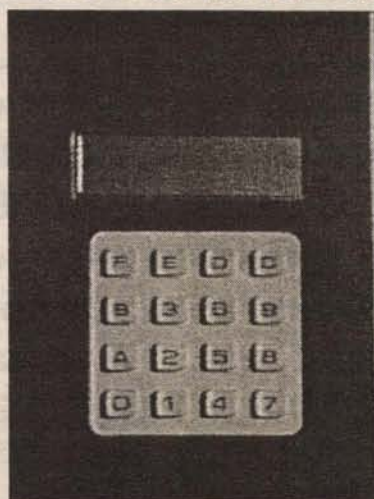
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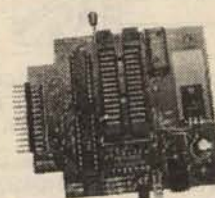
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MORSE CALL SIGNER

by Gerald Fasse

Applying the PARALLAX "BASIC Stamp" Single Board Computer

Background

Amateur radio DXpeditions to some rare and exotic spot is hardly a new concept. Many a pre-World-War II country was activated by adventuresome amateurs for the sole purpose of putting a new one on the air.

A large portion of these operations were by military personnel with the Pacific area favored by USA amateurs, and the middle and near east by UK hams. Exotic spots such as Palmyra, Johnson, Midway, and Jarvis in the

Pacific and India, Bahrain, Burma, and Palestine in the East, when aired, produced the same heart palpitations as they do in this modern day.

Twenty meter CW was the mode of choice for the most part. SSB was an esoteric mode with great potential for DXing, but beyond the average ham in those early days, and while AM served well for the ragchewer, it was not suitable for DXing with power levels available to the average ham. So, crystal-controlled CW was king of the hill for many years.

Leafing through old issues of QST

and *Radio Magazine* indicated that ECOs (Electron Coupled Oscillators) were slowly coming on line, but the bulk of early DXing was done with huge frequency splits! A rare DX station would merely call a fairly long CQ and then tune 1 to 200 KHz across the band looking for a call! A few pleasantries were exchanged, and then on to the next ... It should be evident by this time that long CQs and calls were the order of the day.

The post war period brought with it a flood of new DXers, all brimming with zeal and enthusiasm, and DXing took on a different face. VFOs, better receiver calibration, and savvy operators were collateral effects of the war. Later, the DXpedition tempo increased rapidly as the likes of Bob Denniston W0NWX, Danny Weil VP2VB, Gus Browning W4BPD, and Captain Don Miller W9WNV arrived on the scene. Twenty meter CW was still king, but the rare DX pileups were something to behold. Thousands of DXers, both domestic and foreign would queue up in an instant when a new one appeared on the scene.

Signing one's call sign over and over again trying to break the pile-up could wear down even the most ardent and dedicated DXer. It was this obstacle that prompted the invention of the

thesized Morse have changed all this to say the least. These are invaluable tools because even a well equipped station can spend several hours trying to break a pile-up on a particularly rare DX morsel.

The "BASIC Stamp" Single Board Computer (SBC) is an ideal device from which to build a versatile Call Signer. When this device first appeared in the market place, my first thought was that it could be the basis for a simple and inexpensive replacement for my 25-year-old call signer constructed with DTL integrated circuits. Later, after receiving a pair of sample units, I was astonished to find that someone had already done the hard work, because included in the application note was a Morse routine fashioned from the BASIC-like instruction set provided for the "Stamp."

Despite this, however, some additional work is necessary to include other operational details. For example, some means of external speed control is needed. Also, an audio monitor would be useful at times, and a means of remotely triggering the device would also be handy. The results of all this is noted in the following paragraphs.

Hardware

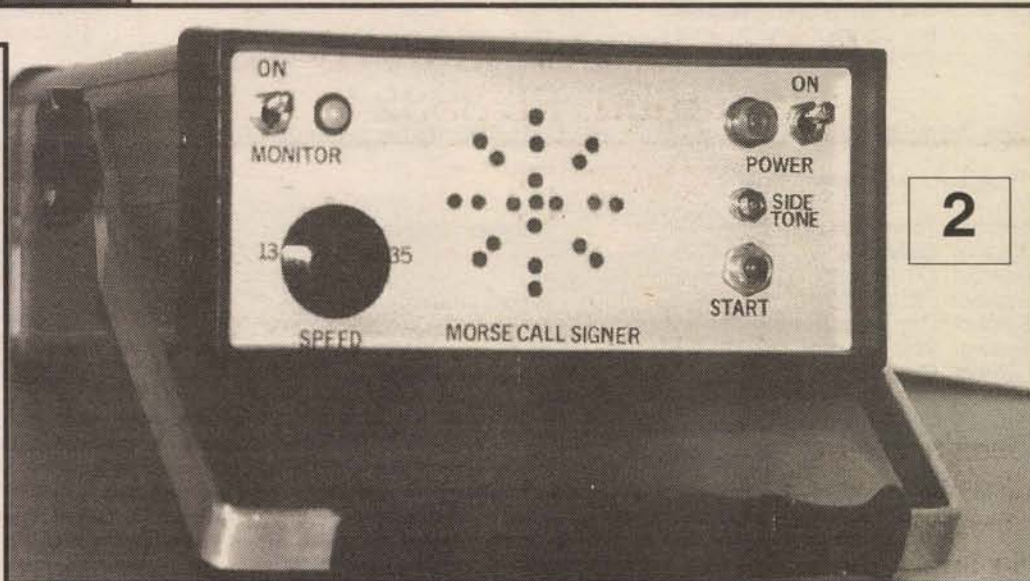
Several variations of the Parallax,



1



3



2

"Gus Stick."

The Gus Stick was a simple concept; a phenolic strip 12-16" long and 2-3" wide with copper segments of strategic size and location cemented along its length. The copper strips were sized such that, when stroked lengthwise with a conductive stylus, one's call sign was dispatched. Speed was easily varied depending upon how fast one moved the stylus across the copper strips. With a bit of practice, nearly perfect-sounding CW would result.

Memory keyers and computer-syn-

Inc., "Stamp" have been noted. These differences were mainly in physical size. The latest version is a 14-pin single inline pack (SIP) with the part number BS1-IC which Parallax notes includes a fool-proof reset system. Some reset problems were noted with earlier versions. A motherboard-style carrier board is also offered which simplifies use of the "Stamp." The carrier board includes a nine-volt battery connector, reset button, and prototyping area, as well as a 14-pin SIP socket and 14-pin single inline header for access to the "Stamp" input/output functions. In

MORSE CALL SIGNER

addition, a three-pin connector is provided for the external programming terminal.

The BASIC Stamp Module sells for \$29.00, or \$39.00 with carrier board. The programming package sells for \$99.00 and includes a cable to connect with the programming terminal. The original BASIC Stamp programming was done through an IBM-compatible PC parallel port. Parallax is offering an upgraded version of the Stamp called BASIC Stamp II. For programming purposes, this version connects to a serial port. The unit has 16 input/output lines, program space for about 600 instructions, a 20 MHz clock, and 9600 baud serial port. Both versions of the Stamp will be compatible with the new programming package. The Stamp II, however, is not compatible with the original programming package. If one already owns the old programming package, the upgrade version sells for \$39.00.

The call signer is fabricated on a Radio Shack prototype board p/n 276-168. There is nothing particularly critical

about the circuit, so scramble wiring is okay. A metal enclosure connected to the station ground is definitely recommended since high-intensity stray RF could cause problems otherwise. The enclosure shown in the photograph was bought at a local ham radio swap for \$3.00. Any resourceful amateur could probably do better! Controls which should be front panel mounted include the power on/off switch, neon power indicator lamp, sidetone frequency adjust potentiometer, Morse speed control switch, and start button. The LED keying indicator L2 is an optional item for visual effect only.

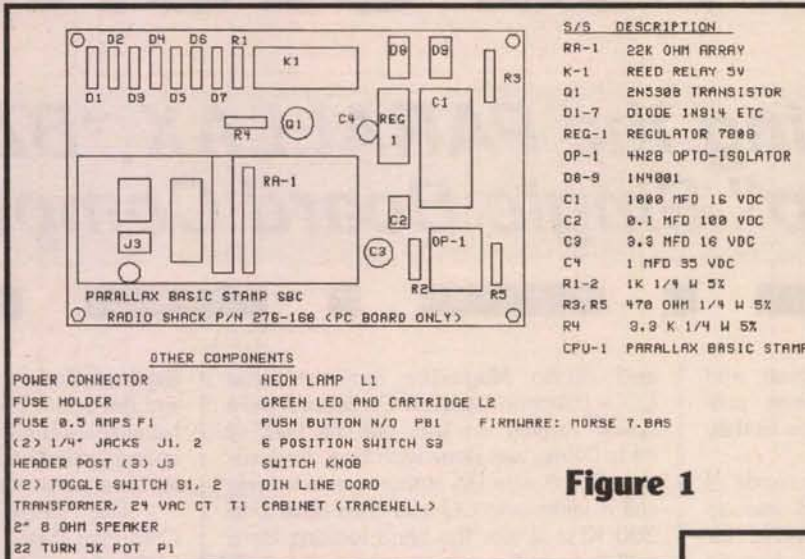


Figure 1

The circuit is straightforward. Note that an optical isolator device, 4N28, is incorporated for the remote start function. Although not truly isolated since both sides of the circuit share a common ground, RF feedback through this line is diminished considerably. A small micro-switch or similar device can be located close to the main station keying system to trigger the call signer. If the call signer can be located close at hand, the remote input function is probably not necessary.

K-1 is a reed relay avail-

able from Radio Shack. It provides a normally open contact for keying the station transmitter. It will easily handle most modern solid-state transceivers since their keying systems are operated with low voltage and current. Some older vacuum tube equipment employing grid block keying can also be keyed with no problems. High-level cathode keying is not recommended with the relay specified. A huskier reed relay with mercury wetted contacts might be better for cathode keying systems.

The 5K ohm sidetone adjust potentiometer can be just about anything one can dig out of his junkbox. The eight-ohm sidetone speaker used in the prototype was salvaged from a junked transistor radio. Although a 22K ohm resistor pull-down array is specified in the parts list,

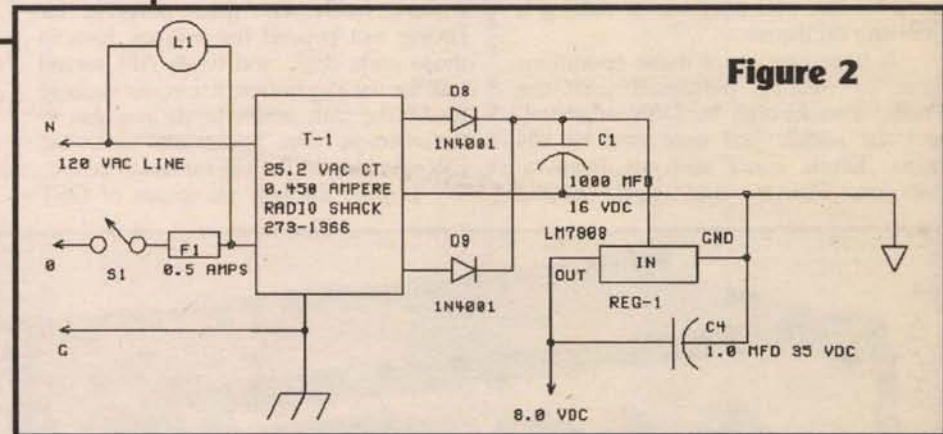


Figure 2

'Basic Stamp SBC Call Signer program

'Sends: "W8UCI"

'Morse Speed from 13 WPM to 35 WPM (13, 15, 17, 21, 26, and 35)

'Port Assignment:

- 0 = Keyed output reed relay coil driver
- 1 = Audio output to speaker
- 2 = Sidetone input frequency adjust
- 3 = Low order speed bit
- 4 = Mid order speed bit
- 5 = High order speed bit
- 6 = Spare
- 7 = Local/remote input start

'See Drawings: CALLSIN0, CALLSIN1, and CALLSIN2 for hardware details.

'Program starts here

Symbol Tone = b5
Symbol Quiet = 0
Symbol Dit_length = b1
Symbol DitDit = b8
Symbol Dah_length = b3
Symbol Wrd_length = 07
Symbol Character = b0
Symbol Index1 = b6
Symbol Index2 = b2
Symbol Elements = b4

Loop: if Pin7 = 1 then Identify
goto loop

Identify:

b7 = pins
b7 = b7 & 56

'Sidetone frequency

'Adjust character spacing

lookdown b7,(0,0,0,56,40,24,32,16,8),b1

'Set speed

let b3 = b1 * 3
let b8 = b1 * 2

'Set dash length (3 x dot)
'Adjust character spacing

Output 0: output 1

for Index1 = 0 to 4

lookup Index1,(99,229,35,164,2),Character

'Morse chars sent

gosub Morse

next

gosub word_sp

goto loop

Morse:pot 2, 105, b5

'Set sidetone frequency

if character = 255 then word_sp
let Elements = Character & %00000111
if Elements = 7 then Adjust1
if Elements = 6 then Adjust2

Bang_Key:

for Index2 = 1 to Elements

if Character >= 128 then Dah
goto Dit

Reenter:

let Character = Character * 2

next

gosub char_sp

return

Adjust1:

Elements = 6

goto Bang_Key

Adjust2:

Character = Character & %11111011

goto Bang_Key

end

Dit:

high 0

sound 1,(Tone,Dit_length)

low 0

sound 1,(Quiet,Dit_length)

goto Reenter

Dah:

high 0

sound 1,(Tone,Dah_length)

low 0

sound 1,(Quiet,Dit_length)

goto Reenter

Char_sp:

sound 1,(Quiet,DitDit)

return

'Adjust character spacing (DitDit)

Word_sp:

sound 1,(Quiet,Wrd_length)

return

MORSE CALL SIGNER

discrete 22K resistors would do as well. The SIP pack is just a little more convenient because of the Stamp carrier board layout.

A word about the speed control select function. Because of inherent limitations in the Stamp SBC, a total of six discrete speeds are available. In approximation, they are 13, 15, 17, 21, 26, and 35 words per minute. However, these values can be changed, as will be explained later. The Stamp II SBC with its 20 MHz clock will allow more flexibility in the speed selection area when it becomes available.

The rear of the enclosure should contain the power connector, fuse holder, keyed output jack, remote trigger input jack, and external programming terminal connector.

Software

A complete listing of the program along with annotations follows. One's call

sign should be placed in the line beginning "lookup Index1." At present it contains the call sign of the author in decimal ASCII form (W=99, 8=229, U=35, C=164, and I=2). See the conversion table provided.

If your call sign is longer or shorter, one other change must be made. The line beginning "for Index1 = 0 to 4" contains the message length. If your call sign is four units long, change the 4 to 3. If your call sign is six units long, change the 4 to 5.

Other characters can be added to the total message. For example, "DE" (this is) can be easily added e.g., DE KF5XXX. Since the space between the E and K must be included, the total message length is now nine units, the "for Index1 = 0 to 4" now reads "0 to 8." The decimal value 255 is a character space. It is not exactly three ele-

ments in length, but close enough for good sounding Morse.

A crude weighting effect can be had

speed switch selects one of six BCD (binary coded decimal) combinations; 56, 40, 24, 32, 16, or 8. The "lookdown" instruction scans this data from left to right. When data stored in register "b7" equals data in the instruction, the relative position of that data is stored in register "b1." For example, if a 40 is encountered, a 5 is stored in "b1" since this is the fifth value in the instruction i.e., 0, 0, 0, 56, 40. Register "b1" would thus contain a 5. By adding or subtracting leading 0s in the instruction, keying speed will be changed either up or down since this would alter the numerical position of speed data.

For example, if a 0 is added (making a total of four leading zeros), speed selection will range from 11.5 to about 28 WPM. Subtracting a zero will change the range from 14 to about 50 WPM. Other keying speed values between will change proportionally.

Ideal word spacing in Morse is 7 elements long (dot length x 7). By holding the start button down continuously, the Call Signer will repeat the stored call over and over. The spacing between repetitions is set at 7 elements. This value can be adjusted by changing the line "Symbol Wrd_length = 07." Smoothest sounding Morse will result with this setting, but it can be adjusted to one's own taste, e.g., 05, 06, 08, 09, etc.

Another limitation became apparent during initial testing when operating the Call Signer at higher keying speeds. Because of the time required for the BASIC Interpreter to resolve each basic instruction, the resulting Morse output sounded a bit choppy. This is a fatal flaw to the ear of a hard-core Morse operator.

A compromise in the timing set-up fortunately compensates for this problem. In the line "let b8 = b1 * 2," all things being equal, the "2" should be "3" based on normal Morse element relationships. Changing this value to "2," makes the whole issue moot as nearly perfect Morse results. NV

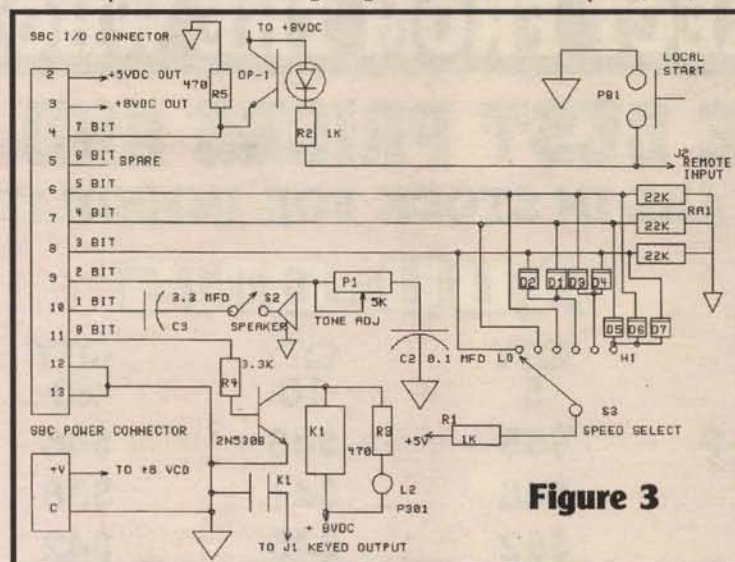


Figure 3

ENCODED MORSE CHARACTERS

Character	Morse	Decimal	Character	Morse	Decimal
A	.-	66	S	...	3
B	-...	132	T	...	129
C	-.-.	164	U	..-	35
D	-.-	131	V	...-	20
E	.	1	W	...-	99
F	..-	36	X	..-	148
G	...	195	Y	..-	180
H	4	Z	...-	196
I	..	2	0	----	253
J	.-	116	1	----	125
K	.-	163	2	....	61
L	.-.	68	3	....	29
M	--	194	4	....	13
N	-.	130	5	....	5
O	---	227	6	....	133
P	.-.	100	7	....	197
Q	-.-.	212	8	....	229
R	.-.	67	9	....	245
/	.-.	149	AR	.-.	85
.	.-.	87	SK	....	23
,	.-.	207	BT	....	141
?	.-.	48	KN	....	181
Character Space		255			

by changing the "let b3 = b1 * 3" line to "* 2" or "* 4." This will lengthen or shorten the dot to dash ratio which by convention is one to three. Since there is a spare input available on the Stamp, weighting could be selected by adding a switch and a few lines of code — details of which we will leave up to the reader.

Keying speed is selected in the line starting "lookdown b7" etc. The 8 integer at the end of the string is the lowest speed while the 56 integer at the beginning of the string is the highest speed. As noted earlier, the Stamp SBC BASIC instruction set has limitations which will not allow finer speed control than set forth here with the BASIC program approach used. However, it is possible to change the lower and upper speed limits which are presently 13 and 35 WPM.

An understanding of the basic instruction "lookdown" is helpful if one plans on changing the keying speeds noted above. Storage register "b7" contains the speed input pins data (only the 3, 4, and 5 bits are applicable to keying speed).

Register "b1" at the end of the statement is where the dot element length is eventually stored. The

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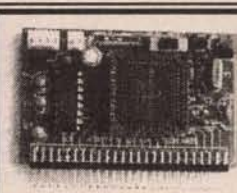
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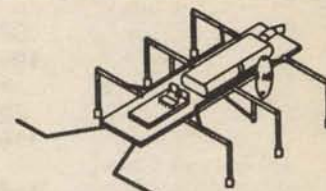
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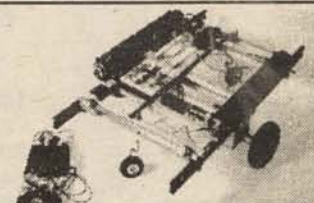
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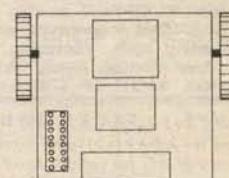
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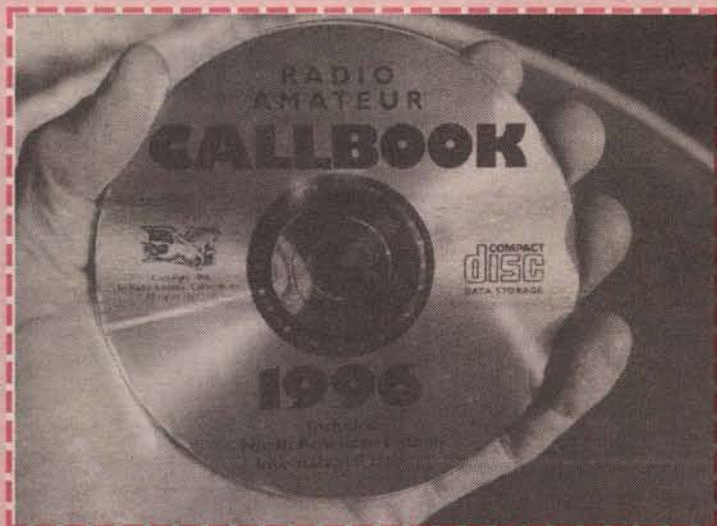


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VERSION 2 OF RADIO AMATEUR CALLBOOK CD-ROM



Radio Amateur Callbooks have been around for as long as the FCC has been issuing licenses. The *Radio Amateur Callbook* was originally developed and printed near Chicago by DX legend Bob Locher W9KNI, and Herb Nelson W9IGL. Long before the age of modern computers and on-line FCC data bases, the *Radio Amateur Callbook* has always been respected as the most up-to-date corrected listings of the United States and foreign amateur radio operators.

"We were a small, but efficient operation," smiles Bob Locher, a familiar name on high-speed CW bands. "And we did everything ourselves," adds Herb Nelson, pointing to the snow plow and forklift he would be running on certain mornings and most afternoons.

There was no competition to the well-established *Radio Amateur Callbooks* — they were considered the "bible" for looking up names and addresses for call signs worked or received over the air.

ALMOST no competition — in 1984, the American Radio Relay League came out with a United States call directory by name index, and the book was well received during its short existence by those who had a name, but didn't have the call sign. Some hams in the book were not pleased that their birthdate year was given!

In 1988, new acquisitions and new directions took place with the *Radio Amateur Callbook* in Illinois. Nelson and Locher added Gordon West Radio School products and Bill Orr books for *Radio Amateur Callbook* dealer and direct-sale distribution. The popularity of West and Orr books contributed to increased growth of the *Radio Amateur Callbook*, and in 1989, the *Callbook* was sold to Billboard Publishing, Inc., in New York with product fulfillment managed by Ted Misa at a huge publishing/distribution center in New Jersey.

Misa carried on the same tradition as Nelson and Locher, with the Pegasus (flying horse) continuing on as a fixture since the company was founded, as well as its role in maintaining the cohesiveness to the amateur community. Indeed, being listed in the *Callbook* is widely considered one of the proofs of membership in the worldwide fraternity of amateur radio; identifying each other, and helping reach each other for QSLs and letters and the like.

"And the timing was perfect," comments Misa, explaining that down-sizing of the FCC would ultimately lead to on-line computer data bases of call signs, and the gradual infusion of digital file retrieval as an option to the phonebook-thick *Radio Amateur Callbook* US listings, and the phonebook-thick *Radio Amateur Callbook* foreign listings.

"We wanted to do it right the first time in producing our *Radio Amateur Callbook* on a digital format, so we took an extra year to bring out our CD-ROM product behind what others in the industry were doing on disks and on their own CD-ROM programs," adds Misa. "But we had something that no one else could obtain, and that was more than 250 countries of international listings plus all North American listings on a single CD-ROM," adds Misa with a smile. This works out to be more than 700,000 licensed amateur operators in North America, and more than 600,000 licensed amateur foreign listings on a single CD-ROM.

In Nov. '95, Version 1 of the *Radio Amateur Callbook* on CD-ROM was released. Amateur operators throughout the world were quick to obtain a copy and install the Windows/DOS platform for US and international data retrieval. Windows icon was driven by the mouse, and DOS driven by menu. The *Radio Amateur Callbook* worked at equal speed as the competition, and was not plagued by a systems crash that plagued many of the other systems when more than one call sign was entered into the program.

"The *Radio Amateur Callbook* on CD-ROM was developed by the German

Amateur Radio Club, DARC, and myself and the staff of the *Radio Amateur Callbook*," comments Ted Misa. "Compiling all of the US, North American, and foreign data bases is accomplished within *Radio Amateur Callbook's* New Jersey facility with five staff members daily inspecting and comparing incoming data to insure complete correctness," adds Misa. "Just because the data comes in from the FCC does not necessarily mean it is clean of typos," adds Misa. "We double check everything, and clean up errors to insure radio amateurs have the most up-to-date and accurate data available," comments Misa.

Version 1 of the *Radio Amateur Callbook* CD-ROM allowed operators to search US stations by call sign, last name, county, city, or zip code. International data could be searched by call sign or text search by name, street, city, province, or region. Data is displayed by call sign, last name, city, license class issued, and expiration date of that license as a reminder when it is time to renew.

There are also listings of past and present clubs, military stations, and silent keys.

"We also include some Morse Code training to illustrate the audio capabilities of the CD-ROM format," states Misa. There are also listings of time zones, latitude and longitude listings, and phone area codes, too.

In just one year, the *Radio Amateur Callbook* CD-ROM Version 1 led in popularity over four other products from the competition. Clearly, amateur operators liked the no-nonsense approach to a single CD-ROM containing almost everything at their fingertips.

Well, almost everything — any Version 1 product is bound to have criticisms, and most notably was the Version 1 print layout of a single call sign data in a companion logging program to issue QSL mailing labels.

"I would have liked the capability of multiple printing and a format that would fit my QSL card logging program," comments Bill Alber WA6CAX. There were also comments that the operator's birth date should be listed, and country name should be included in a special area of foreign listings.

Version 2 of the *Radio Amateur Callbook* CD-ROM is now available. An improved print program allows for multiple entries to customize a mailing label or logging format, giving contesters double-duty operation in recording call signs and automatically printing customized fields of label or QSL addressing. Birth dates are now available, and countries are now an active part in the foreign program.

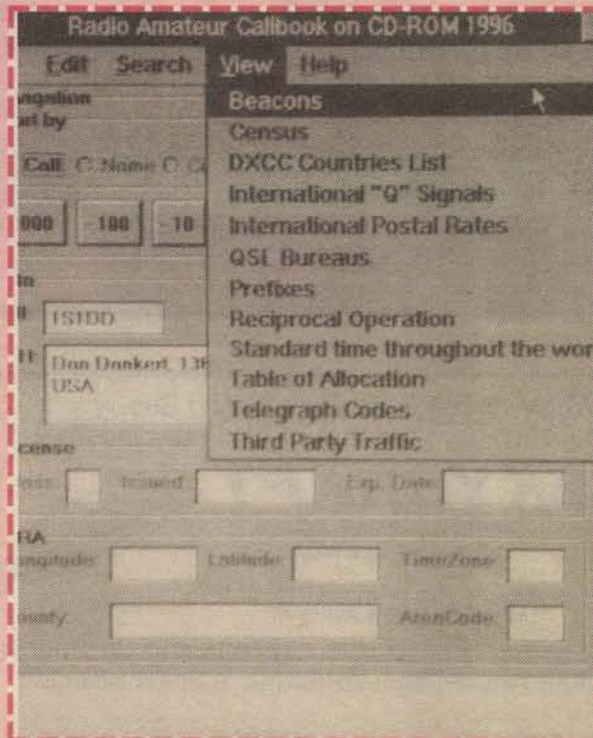
"Here at *Callbook*, we listen carefully to our customers, and we will continually update our products to stay well ahead of the competition," comments Misa. "Our new Version 2 also contains QSL managers along with what we already have for QSL bureaus. Our QSL manager data base is just one more way we give contest operators the ultimate edge in complete logging and QSLing data base."

Version 2 of the *Radio Amateur Callbook* on CD-ROM sells at the same price as Version 1 for a suggested retail of \$49.95. Will *Callbook* on CD-ROM signal an end to the big, thick paper *Callbooks*?

"Our paper *Callbook* sales continue strong from our valued dealers, so we will continue to produce both printed *Callbooks* in a North American and separate foreign edition, plus the North American and foreign combined CD-ROM *Callbooks*," comments Misa. "When newspapers, paper books, and paper phone directories make way for everything on computer, only then will we consider dropping our popular phonebook-sized paper *Callbooks*. And we will continue to offer special listings in the paper *Callbooks* for those amateur operators wishing their call sign and name and address to really stand out."

I wonder how they are going to do that in the CD-ROM version — maybe flashing stars and blinking lights?

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Web Site? Web Site?

Yes! We have a Web site! We have had one for several months now, but have used it exclusively for advertising and promoting *Nuts & Volts*.

Starting this month, however, we will be posting files to our [reader download library](#) and begin converting the site to an on-line reader resource!

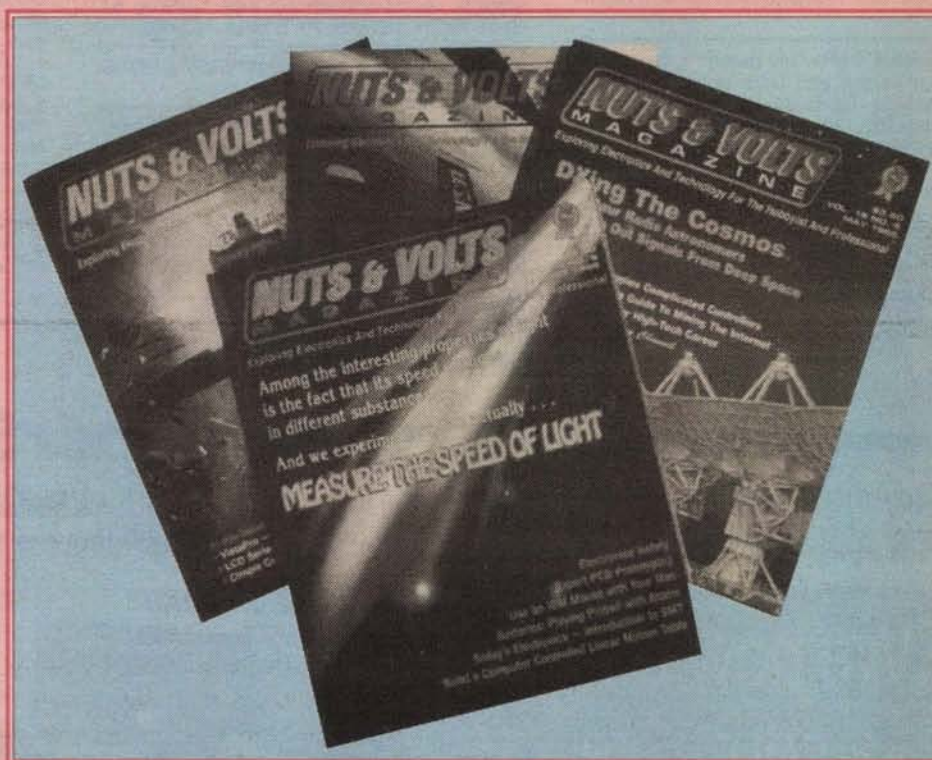
You will be able to download specific programs that are mentioned or reviewed in articles, such as this month's "Talking With MIME" by TJ Byers.

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We're very excited about this new "feature" of *Nuts & Volts* and hope that all of our readers will find it interesting and useful. Keep in mind that we are currently developing the site, and that the different features mentioned above will be coming on-line very shortly. The projected date to download library files from this issue is May 8th.

The URL for the site is <http://www.nutsvolts.com>

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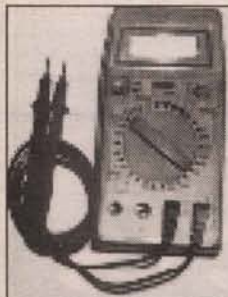
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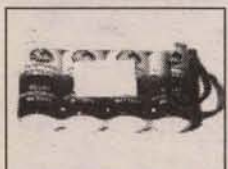
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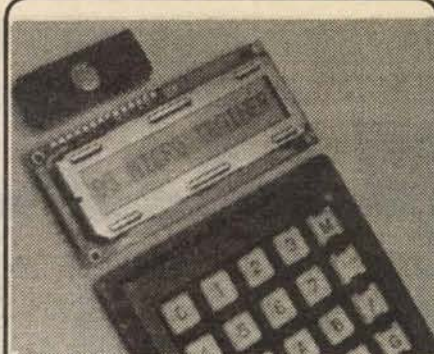
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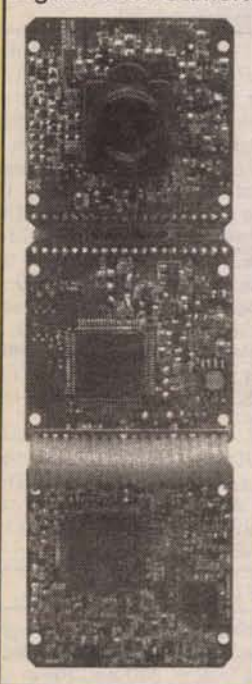
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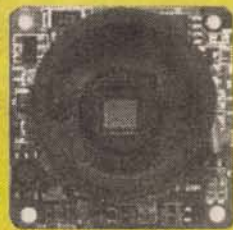


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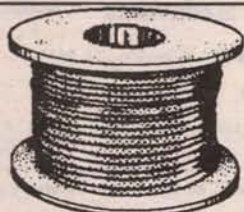
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by Karl Lunt

The Ultimate PC Robot Tool

This all started, naturally enough, at a Seattle Robotics Society (SRS) meeting. The SRS members constantly explore different chips and boards, looking for ways to build better robots faster. At the Jan. '96 meeting, the group tech session turned to using PC tools as a method of speeding up a robot's design.

Dick Martin mentioned the Intel 386ex microcontroller (MCU). As you can surmise from its name, this chip contains an 80386 core, built of CMOS technology and able to run any 80386 software. Additionally, Intel grafted on gobs of I/O normally needed to build a PC. This includes DRAM refresh circuitry, parallel ports, serial ports, and timers.

The ability to work with a machine so much like a PC, yet containing valuable robotic staples on-chip, makes the 386ex a serious consideration

AMATEUR ROBOTICS

chip and two 32-pin memory sockets. The V25 supports up to 1 MB of memory, so you could drop a 512 KB RAM chip in one socket, then stick a 512 KB EPROM in the other. One nice aspect of the V25 chip: it runs the 8088 instruction set directly. Thus, you can create working code for the V25 using just about any PC-based compiler.

The start of BOTBios

All this talk about PC-compatible robot boards got to a couple of us software types. Bill Bailey, who does a lot of work with PC-based software, was talking about an idea he had for mutating PC software so it could run on an 8088-type chip, such as the V25. Our conversation stretched out, off and on, over several days and took plenty of twists and turns before settling down to a concept Bill calls BOTBios. I'll describe the BOTBios system using a V25 chip, but remember that it works equally well with any 8088-compatible micro.

BOTBios resides in an EPROM of up to 64KB in size, and is wired into the top portion of the V25's memory space. The BOTBios ROM contains code for handling power-on reset, plus support for selected V25 interrupt vectors. See the accompanying layout of the BOTBios ROM.

The layout shows the BOTBios ROM extending from some starting point up to linear address FFFFFh. I say "linear" because the V25 uses a segmented architecture similar to the PC's. Thus, it divides its 1MB address space into 16 64KB blocks. You normally refer to a specific address by supplying both the 16-bit memory segment and the 16-bit segment address. For example, you might refer to the address of the reset vector as segment FFFFh and address 0000h.

The V25 chip internally combines these two numbers to create a single, 20-bit linear address. It does this by

multiplying the segment by 16, then adding it to the segment address. For the reset vector example, this becomes FFFF0h added to 0000h, or FFFF0h. Since I'm accustomed to thinking in linear address spaces, I'll generally refer to addresses in this article in their linear form.

The starting address of a BOTBios ROM varies, depending on the size of the EPROM defined when the code is assembled. Bill has so far assembled his BOTBios code to reside in an 8KB EPROM (27c64), so the BOTBios entry point for such an EPROM is at FE000h.

While the layout shows the EPROM extending all the way up to FFFFFh, the V25 actually overrides the top 512 bytes of this address space. The MCU reserves these bytes for its Special Function Registers (SFRs) and 256 bytes of on-chip RAM. With few exceptions, data written into the BOTBios EPROM at these addresses will not appear in the address space.

One obvious exception to the above is the 12 bytes of memory starting at the reset vector at

FFFF0h. Following reset, the V25 sets its program counter (PC) to linear address FFFF0h and starts execution at that address. Bill's code assembles a far jump to the start of BOTBios at that address, so the V25 can reach code cleanly after reset.

Once the V25 completes its reset sequence and actually begins executing BOTBios, the fun really starts. Bill's code provides some very powerful services that meet the needs of robot designers, while remaining compatible with PC software tools such as Basic and C compilers.

The best example of this merging lies in the BOTBios interrupt service routines (ISRs). As the name implies, BOTBios provides a limited set of BIOS support, similar to that found in a PC BIOS ROM. Bill has, of course, modified these ISRs to fit into the robot world.

Most code generated with PC compilers relies on BIOS and DOS interrupt services to perform low-level I/O tasks. For example, the PRINT statement in most Basic programs eventually ends up executing a BIOS interrupt 10h, service 0eh (Write Character in Teletype Mode). When the Basic program invokes this interrupt on a PC, BIOS code writes the character to the video monitor so the character occupies the current logical output position on the screen.

Since most robots don't have video screens, Bill coded BOTBios so this interrupt and service combination sends the specified character out serial port 0 on the V25. Thus, a PC program that prints "Hello, world!" to the PC's monitor would, if run under BOTBios, send the same text out the serial port instead.

Similarly, Bill has written ISR code for interrupt 16h, service 00h (Read Next Keyboard Character) so it accepts input from the same V25 serial port. This means that a C program that uses the getch() function to read a character from the PC's keyboard will work just fine under BOTBios; it will simply read a character from the serial port instead.

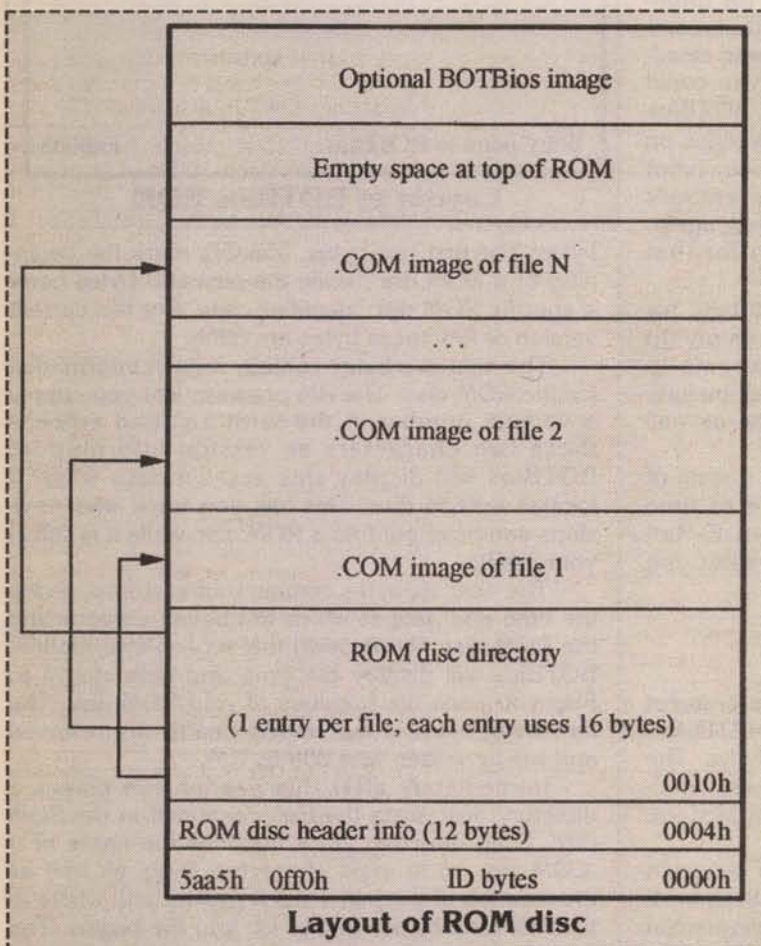
I intentionally used two different languages, Basic and C, in my examples above to make a point. It doesn't matter what language you use to write your robot code, so long as the compiler uses the PC's BIOS routines in a well-behaved manner. Whether it's Pascal, Fortran, C, Forth, assembler, or COBOL, you can use it to write robot code and run that code in the BOTBios environment.

Having said that, I need to add a couple of caveats. First, your selected compiler must actually generate ROMmable code; specifically, it must be able to create .COM files. Not all "compilers" can do this. Some, like the recent Microsoft Basics, can only execute a program from within the Basic development environment.

Second, Bill's BOTBios must include support for the interrupt services your program needs. Obviously, Bill has not added disc services, though discussions are under way. Similarly, those video services that deal with graphics modes and screen manipulation aren't available in BOTBios.

But if Bill has provided the needed support routines, and your compiler makes a .COM file of your program, you should be able to run your PC application under BOTBios.

One of the first options that BOTBios opens up is real-time debugging output from your robot code. Since your compiler does the nasty formatting work before it invokes the BIOS routines to



for large robot systems. The major disadvantage, from a hobbyist standpoint, is the chip's packaging. Intel used a plastic quad flatpack (PQFP) design, with 132 pins on very fine pitch spacing. This layout forces the use of a fine pitch circuit board, most likely double-sided, just to hold the chip.

Ambitious hobbyists can probably fabricate an adaptor board to hold the 386ex and bring the signals out on wirewrap or IDC-type connector pins. This would let you plug a larger adaptor board into your main board, so you could use the 386ex on a prototyping board.

Others at the SRS were thinking along similar lines. Mark Casteluccio brought in a small V25 MCU board he had purchased through the mail from Tern, Inc. The company offers several variations of V25 (and other) boards, plus a suite of add-ons specifically tailored for embedded control. You can tap into Tern's FTP site at: <ftp://ftp.netcom.com/pub/te/tern>

The board Mark showed off contains the V25

send data to the screen, you can add all kinds of fancy debug statements to your code. You might hesitate to write a formatted output for eight different 16-bit values in assembler, but under BOTBios, you just make a call to the `printf()` function and you're done.

As the BOTBios layout shows, Bill has added several features beyond BIOS support. BOTBios also contains a command-line interpreter (CLI). The CLI works just like the DOS prompt on a PC, in that you can type commands at the prompt and see them executed.

Since Bill's BOTBios has already replaced the PC's keyboard and video display with the V25 serial port, it was a natural step to connect the BOTBios CLI to the serial port as well. You can hook a robot running BOTBios to the serial port on your PC and fire up a comm program such as ProComm. When you reset the robot, you will actually see a command-line prompt on your comm program.

So what kind of commands can you run from the BOTBios CLI? Recall that I said your compiler must be able to create .COM files. BOTBios automatically reads the command you enter and scans its ROM, looking for a .COM file of the same name. If it finds a match, BOTBios copies the file into on-board RAM and executes it. If the program later terminates cleanly, using interrupt 21h, service 00h (Terminate), control will return to BOTBios and it will prompt you for your next command.

I really like the power this feature offers. I can have a tethered robot capable of many different functions, waiting for my command. If I issue a command to send temperature data, it dutifully runs the GETTEMP command and streams the data back down to me over the serial line. If I then need to determine the robot's battery charge level, I just run that command.

Since the BOTBios CLI will run just about anything you can turn into a .COM file, you could even put small compilers on-board. I'm thinking specifically of a modified Forth compiler for the PC. Most Forths come with source code, and it would be a fairly simple task to strip out all of the disc I/O words. This would leave you with an interactive program development system running on your robot.

BOTBios also includes software interfaces to much of the V25 on-chip hardware. As noted, many of the standard PC BIOS routines have been rewritten to use one of the V25 serial ports instead. As of this writing, Bill is also looking into adding newer interrupts for accessing V25 subsystems such as the timers and analog ports. Much of this work is still ongoing, and I'll keep you posted as it evolves.

One low-level feature that is already available, however, is the Intel hex file loader. At the CLI command prompt, you can simply begin downloading an Intel hex file to your robot. The colon (:) at the start of each line marks it as an object record, and BOTBios parses the record out, stores the data into the appropriate area of RAM, and prompts for the next command. Thus, you can send a complete hex file anytime you see the command prompt, and you can send as many hex files as you like.

The built-in downloader makes program development a snap. Just create your .COM file, translate it into a hex file, and send it over the serial port to your robot. Issue the BOTBios built-in GO command, and your program runs. When your program ends, BOTBios regains control and you are ready to send the next file.

The last feature on the BOTBios layout diagram is the power-on reset dispatcher. This concept has no analog I know of in the PC world; it is primarily a robotics device, and a very powerful one at that.

Immediately after reset, BOTBios checks the low four bits of the V25's port 0 (P0.0 through P0.3). It uses the state of these four bits, usually wired to a set of dip switches, to generate a hex number from 00h to 0fh. BOTBios then uses this number, called the dispatch value, to determine

what to do next.

If the dispatch value is 00h, BOTBios automatically transfers control to the CLI. This is the normal method of start-up, and assumes you have a serial terminal of some type hooked to the robot.

If the dispatch value is 0fh, BOTBios does a blind jump to address 00100h. This is the normal execution point of a .COM file, and it is also the starting point of any Intel hex file that you download into RAM. This feature lets you load a hex file into battery-backed RAM, then reset your robot so all V25 devices come up cleanly. Control will automatically start running your program, bypassing much of the BOTBios start-up code. Note, however, that if your program terminates, BOTBios will again gain control and you will see the CLI prompt.

Finally, if the dispatch value is in the range from 01h to 0eh, BOTBios assumes you want to run a stored .COM file. It automatically searches through its ROM space, locating .COM files stored there when the ROM was programmed. It finds, loads, and runs the N'th .COM file, depending on the dispatch value. Thus, a dispatch value of 03h causes BOTBios to load and run the third .COM file it finds.

This feature will prove most useful on multi-purpose robots. If you design a robot that competes in, for example, the line-following and dead-reckoning events at a club competition, you could burn the necessary .COM files into the BOTBios ROM. At the first event, just set the dip switches on port 0 to the proper value and hit reset; your robot runs the correct program. When the next event rolls around, change the dip switches, hit reset again, and the same robot runs the program for that event.

As of this writing, Bill intends to distribute his BOTBios software by making it available on my ftp site. I don't know for sure what he expects to include in the distribution, but it may well include full source code for the BOTBios routines, as well as sample implementations.

Please note that BOTBios is likely in a state of permanent development, and will evolve as time goes by. Bill will doubtless provide an E-Mail address for feedback, so let him know what you think of BOTBios.

The ROMMAKER program

I've repeatedly mentioned above the concept of burning .COM files into a ROM, and BOTBios' ability to search a ROM for named .COM files. The program that provides BOTBios with these functions is my contribution to the BOTBios system, and is named ROMMAKER.

ROMMAKER (or RM) is a PC-based program that creates an EPROM image from a collection of .COM files. RM places the .COM files in a sequential order, prepends a custom directory and header, and outputs the entire image as a binary file, ready for burning into an EPROM.

Bill and I refer to this resulting EPROM as a ROM disc. A ROM disc can reside anywhere in the V25 address space, though it makes most sense to place it at 20000h and above, to leave room for a minimum of 128K of system RAM. A brief tour of RM's output file will clearly show how well the design meshes with BOTBios. Refer to the accompanying layout of a ROM disc.

Unlike a BOTBios ROM, a ROM disc basically "starts" at the lowest address, which is ROM address 0000h. All elements in a ROM disc are completely relocatable, and a ROM disc works, regardless of where in the address space you install it. Therefore, I'll refer to addresses inside a ROM disc as relative to the start of the EPROM, rather than relative to the V25 address space.

The first block of information in a ROM disc is the disc's header, used by BOTBios to find the ROM disc when it searches memory. The header takes up 16 bytes, and starts with four identifying

Special Function Regs	FFFFFh - FFF00h
Reset Vector	FFFF0h
On-chip RAM	FFE00h - FFEFFh
Bottom of stack	FFE00h
Copy of BOTBios Vectors	
These are moved to RAM vector area following reset	
BOTBios code	
Interrupt service routines	
Command line interpreter	
Low-level hardware interface	
Power-on reset dispatcher	
Entry point to BOTBios	Fx000h

Layout of BOTBios ROM

bytes. The first two bytes, 05aa5h, mark the beginning of a ROM disc, while the next two bytes carry a specific ROM disc identifier code. For the current version of RM, these bytes are 0ff0h.

The next two bytes contain version information for the ROM disc. The RM program lets you supply a version number in the form x.y, and embeds these two characters as version information. BOTBios will display this version data when it locates a ROM disc. This lets you track what revisions you have put into a ROM disc while it is still in your robot.

The next six bytes contain a time stamp, giving the time and date at which RM began constructing the ROM disc file. As with the version information, BOTBios will display the time and date stamp to help you track the revisions of your ROM disc. The remaining bytes in the 16-byte header are reserved and will be written with 00h by RM.

Immediately after this header, RM places a directory describing the files contained in the ROM disc. Each directory entry contains the name of a .COM file, up to eight characters long, as well as the location of the initial stack pointer and where in the ROM the binary image for that file begins. The actual length of the directory depends solely on the number and size of the .COM files involved, and the size of the final ROM. If you have a large EPROM, say 512KB or so, you could probably fit a dozen or more small .COM files into your ROM disc.

I won't go into a complete discussion of RM; you can download the distribution files from my ftp site and read the included manual for that. I will, however, walk you through a single example of using RM to build a ROM disc. This will give you a feel for the power in the BOTBios/ROMMAKER system.

Assume you have written three programs to run on your V25 robot. GETTEMP.COM returns some temperature readings, SONAR.COM takes a 360-degree sonar sweep and returns the data, and SETUP01.COM lets you download some information to the robot describing the tasks it must perform in the next 24 hours.

You know the amount of stack space each file requires, and you know that GETTEMP.COM can actually run out of ROM. This means that BOTBios won't have to copy the GETTEMP program into

RAM before executing it; it will simply execute the ROM image directly.

Regardless of which languages you used to write these programs, the resulting executables exist as .COM files on your PC. Now you want to use RM to create a ROM disc image for burning into a 256KB EPROM. Just for grins, you also decide you want this ROM disc to contain a copy of the latest BOTBios binary image, which is in the file V25BIOS.BIN. Finally, you want this ROM disc to contain a version number of 2.1, so you can track the changes you made since the last revision.

You start by opening a text file (call it MYDISC.BLD), and entering the following lines:

```
*
* MYDISC.BLD builds a ROM disc
*
ROMSIZE 256
VERSION 2.1
FILE c:\v25\bin\gettemp.com gettemp 100 ROM
FILE c:\v25\bin\sonar.com sonar 200
FILE d:\foo\setup01.com setup 100
BIOS d:\incoming\v25bios.bin
```

The above commands are pretty self-explanatory, and illustrate the simplicity of the RM command file. The ROMSIZE command declares the size of the final ROM image, in kilobytes. The VERSION command provides a three-character version identifier, of the format x.y. Each FILE command provides the path to the desired .COM file, the name for that file that will appear in the ROM disc, and the amount of stack space, in 16-byte paragraphs, needed by the program. If you include the optional keyword ROM at the end of a FILE command, that directory entry will be flagged as capa-

ble of running from ROM; see the FILE command for GETTEMP above.

Note the FILE entry for the SETUP01.COM file. This shows an instance when the PC version of the .COM file is named differently from the directory entry as it will appear in the ROM disc. This lets you change the revision of the underlying .COM file, while maintaining the same name across several ROM discs.

Finally, the optional BIOS command causes RM to append the file V25BIOS.BIN to the top of the ROM image, located so it will execute properly on reset of the target V25 board.

To actually create your ROM disc, run the ROMMAKER program by entering:

ROMMAKER MYDISC

ROMMAKER will open the MYDISC.BLD file, execute the commands it finds, and leave behind a binary image file named MYDISC.BIN. This binary file will be exactly 256KB long, and can be directly loaded into most EPROM programmers, such as the Needham PB-10.

The hardware

During our development phase, Bill and I relied on the New Micros' NMIX-0025 single-board computer. I looked at a couple of different V25 boards, and settled on the New Micros' unit for a couple of reasons. First of all, I've done several projects, both hobby and professional, on New Micros hardware, and like their board designs a lot. Second, all of their development boards come with a very large prototyping area and full connector layout, making it easy to upgrade and add on to the board. Finally,

their boards include three 32-pin memory sockets, giving you lots of options as to RAM/EPROM mix and sizing.

I quickly added the appropriate robot-type connectors, such as my standard four-pin male MTA serial connector, a two-pin MTA power connector, a four-position dip switch, power switch, and power-on LED. I also wired a bicolor LED to two of the V25 output lines, so my robot board could at least signal when it was alive.

I then rewired the jumper section so my V25 board supports a 256KB static RAM from 00000h to 3ffffh in the first memory socket, a 32KB EPROM from 80000h to 87fffh in the middle memory socket, and a 32KB EPROM from 0f8000h to 0ffffh in the third memory socket. This arrangement lets me have a BOTBios and

ROM disc combination in the top memory socket, as well as a secondary ROM disc in the middle socket, for experimentation. Since BOTBios can locate and use multiple ROM discs, this arrangement gives me ample flexibility for playing with new .COM files.

You can use the BOTBios/ROMMAKER system on other V25 boards, including the Tern board. In this case, you only have two memory sockets to play with, so you'll have to use RAM in one socket and put a BOTBios/ROM disc EPROM in the second. That's a little less flexible than the New Micros' board, but certainly workable.

Once we had our V25 boards modified, Bill and I sat down at our respective machines and began coding our assigned portions of this project. Bill did all of his work in MASM, the 80x86 PC-based assembler, while I wrote ROMMAKER in Microsoft C.

The coolest part, however, was developing the .COM files we intended to try out on our new V25 hardware. Rather than stick with MASM or MSC, I snooped around on the net, looking for a Basic compiler that could generate .COM files. I finally found a program called ASIC (for almost Basic) version 5.0. This shareware compiler makes VERY small .COM files that run fast, just what you need for those robot programs.

Bill and I took turns writing small .COM files, burning them into a disc ROM, installing them in our V25 boards, and testing the results. Initially, we used ASIC to weed out the BIOS interrupts that Bill needed to support. Later, we used ASIC to create programs that directly manipulated the V25 I/O subsystems, using PEEKs and POKEs.

If you would rather use a more full-featured Basic for your programs, see if you can scare up one of the older Microsoft Basic compilers. The older versions, up to about 5.0, actually created .COM files for stand-alone execution. This is ideal for use with the ROM disc system we've devised.

In conclusion

This was a large software effort, but it unleashes power way out of proportion to the effort Bill and I expended. Whether you run BOTBios on a V25 or a 386ex board, you will find it to be a simple, powerful system that offers great flexibility in dealing with robot software design. The ROM discs open the door for adding PCMCIA cards to your robot, or hacking some of those surplus EPROM cards that are always appearing on the market.

My thanks to Bill Bailey for the opportunity to work with him on a project that took me into personally unexplored realms, the innards of the PC BIOS. And thanks, as always, to those in the SRS who once again aimed me in an interesting direction. **NV**

As always, you can reach me at:

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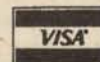
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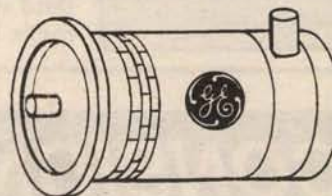
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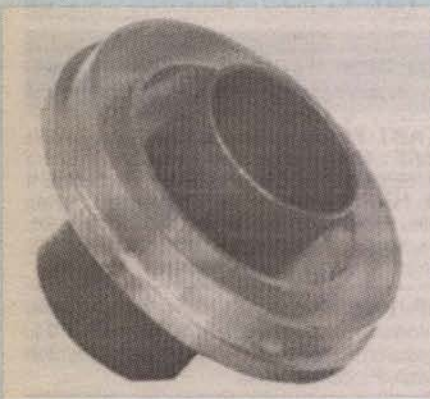
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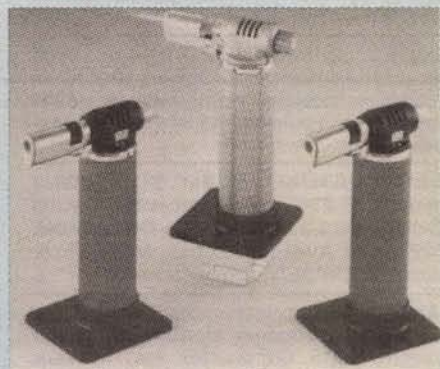
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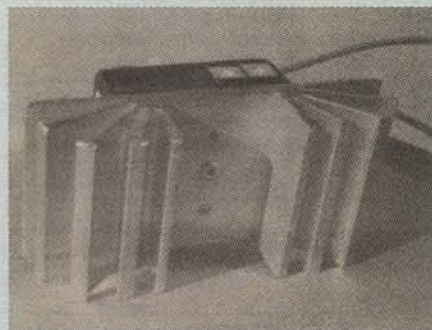
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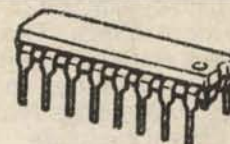
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Continued from page 81

TECH FORUM

able to hear it on that frequency while it is above your horizon. Many scanners do not cover this frequency nor do they allow for reception of amplitude modulated signals.

Some shuttle missions carry the "Shuttle Amateur Radio Experiment" (SAREX), which allows astronauts to make contact with radio amateurs on the ground. Sarex transmits on either 145.55 MHz or on 145.84 MHz depending on the mission. The Russian MIR space station is also occasionally active on 145.55 MHz when the crew is awake, usually when it is daytime at the control center in Moscow.

You can watch TV coverage of shuttle missions on your TVRO dish by aiming it at Spacenet 2, transponder 5, channel 9 at 69 degrees west longitude, with a video frequency of 3880 MHz and audio on a 6.8 MHz subcarrier. There is also a space shuttle web site at <http://shuttle.nasa.gov>

Daniel Schultz
Greenbelt, MD
n8fgv@amsat.org

ANSWER TO #49661 - APRIL 1996

No, you can't convert a door peep hole into a viewable image from outside. The door peep hole viewing lens is recessed into the fixture. Even if one over-reversed the optics, the view would be restricted to the very narrow angle straight out of the viewing hole.

Travis Brackeen
St. Louis, MO

ANSWER TO #49623 - APRIL 1996

Almost all printers emulate one of the major manufacturers of printers such as Hewlett Packard, IBM, Epson, etc. Whenever I can't find printer drivers for printers such as your Oasys, I first connect the printer to my computer. Then I make sure that the printer can communicate with the computer. If it is a standard parallel connection,

this means something will print if you hit print screen. Next, pull up a test document in the word processor. This document may have come with your software or you can make one. It should have a range of different type styles and graphics so that when it prints you will know if it is printing everything correctly. Next, I select a printer driver and print the test document using this driver. If it looks wrong, I try another driver until I find one that prints everything correctly. Since you have a laser printer, you can narrow your search by using only laser printer drivers. Also, I would start with HP laser printer drivers.

Michael Young
Newville, AL

ANSWER TO #49640 - APRIL 1996

If you're not fussy about doing math in your head, you can pick up an inexpensive frequency counter and just connect it to the local oscillator of your receiver. You'll have to add the first IF frequency for your radio to the value on the display to get the actual frequency. Not pretty, but with a hamfest, special frequency counter you could pull this off for just a few dollars. A more professional approach is to use a commercial add-on readout such as a Palomar PD-700. These are simple to hook up and do the math for you. Palomar can be contacted at 619-747-3143.

G.R. Scott
Alexandria, VA

ANSWER TO #49617 - APRIL 1996

A disk duplicator program called CopyM made by Sydex, Inc. (P.O. Box 5700 Eugene, OR 97405, 503-683-6033 voice, 1-800-43-SYDEX Visa/MC orders only, 503-683-1622 FAX, 503-683-1385 BBS, hours 9 am to 5 pm PST, Monday through Thursday) will solve his "key disk" problem,

considering that the key disk is not physically altered and that the platform is a PC (not a Mac or some other proprietary platform), and would allow duplicate key disks to be made for safety backups. The CNC software disks including the "key disk" may easily be backed up on a tape drive such as an external "Iomega Easy 800" (I have one and it works — other brands may or may not work better) for restoration on a blank disk (the exception being if a physically altered "key disk" is used). If you use a PC, set the CMOS to not read the floppy on boot-up so you can leave the "key disk" in the drive all the time and not have to handle it. If your CMOS cannot be set to disable the floppy seek at boot, either get another BIOS chip that does, or swap out the motherboard with one that does have a BIOS with this capability. Most of the mainline modern BIOS chips have this feature — AMI among others do. Check before you buy; if the vendor cannot verify this, find another vendor that is honest!

Stanley Link

ANSWER TO #49625 - APRIL 1996

There are a variety of commercial TV antennas, ranging from poor to very good. All antennas have to compromise on certain qualities, including directivity, gain, bandwidth, size, cost, etc. Most of the consumer type antennas you see on the market are intended to cover the full VHF-UHF range, with performance pretty much commensurate with cost. If these are the types of antennas that Mr. Lyons has already found unsuitable, he has several options. He certainly can build his own antenna, and the *ARRL Antenna Book* and a number of others have design information. If he has enough room, some very high-gain antennas can be built for the VHF-UHF range using wire elements at very low cost.

But the effort and time involved may make this option unappealing. The other option is to order a specialized commercial antenna from a dealer that carries the product lines of companies like Winegard or Jerrold. These manufacturers make a wide variety of specialized TV antennas to suit almost any situation, including single channel, high-performance models. But the cost can be rather high.

Roger Leone K6XQ
Vallejo, CA

ANSWER TO #4965 - APRIL 1996

The DB9 monitor pinouts are:

	Monochrome	CGA	EGA
pin 1	ground	ground	ground
pin 2	unused	unused	secondary red video
pin 3	unused	red	primary red video
pin 4	unused	green	primary green video
pin 5	unused	blue	primary blue video
pin 6	intensity	intensity	secondary green video/intensity
pin 7	video	unused	secondary blue video
pin 8	horiz. sync	horiz. sync	horiz. sync
pin 9	vert. sync	vert. sync	vert. sync

The CGA monitors have the right scan rate for NTSC video, but they have digital TTL-level RGBI inputs. To convert them to composite NTSC video you would have to add a video demodulator and analog video preamps. This is probably not feasible compared to buying a used composite input monitor.

David DiGiacomo
San Francisco, CA

ANSWER TO #49630 - APRIL 1996

Check out my article "Lamp Dimmers and Creative Lighting Control" in the Feb. '96 issue of *Nuts & Volts*; it's just what you are looking for.

Jeff Mazur

ANSWER TO #49635 - APRIL 1996

There are a number of remote gain control ICs available. They go by different names such as "AGC amp,"

"electronic attenuator," "DC volume control," or "analog multiplier." A good, inexpensive part is the Philips TDA1524A Stereo Audio Control, which is available from Javanco, 1-800-428-2626. An older part which is widely available is the Motorola MC3340 Electronic Attenuator. If you want digital control of the gain, try the National LM1971 or LM1972.

David DiGiacomo
San Francisco, CA

ANSWER TO #49616 - APRIL 1996

If you only need a few mA of DC, there are several manufacturers of line-power linear regulators. Supertex 408-744-0100 makes one called the LR6. It will supply 3 mA continuous, 30 mA peak. The big drawback to using these types of devices is that your circuit is not isolated from the power line. Power Integrations 408-523-9265 makes an off-line switching regulator called the TOP210 which can handle up to 5 watts, but it requires a special transformer and a number of other components. If you need AC, a transformer is the only practical way to go (you could use a dropping resistor, but watch your power dissipation [this is also not isolated]).

Robert Zusman
Scottsdale, AZ

ANSWER TO #49626 - APRIL 1996

To connect a video camera to a non-composite monitor (such as a SVGA monitor), you'll need to build a sync and color separator circuit — not a trivial task. Commercial devices to do this cost about \$1600.00. A simpler approach is to obtain a video capture card, such as the Video Blaster, which accepts a video input and displays it in a window on your monitor. These boards are available for \$150-\$200 and connect to your existing video card using the "feature connector."

G.R. Scott
Alexandria, VA

ANSWER TO #49651 - APRIL 1996

The Nov. '76 issue of *QST* magazine had the information on a tube substitute for the 6HF5 that Mr. Collin is seeking. It is on page 42 in the "Hints and Kinks" column. The tube used to replace the original 6HF5s in Swan (and other radios using the 6HF5 sweep tube as linear amplifiers) is the 8950. This is not a direct plug-in replacement, however! The two amplifier tube sockets must be partially rewired in order to use the 8950. After modifying the sockets and installing the tubes, the driver stage must be retuned to compensate for the different interelectrode capacitance of the new tubes, and the amplifier will need to be reneutralized. The 8950 tubes have been available in the past from RF Parts, a regular advertiser in *Nuts & Volts*.

Roger Leone K6XQ
Vallejo, CA

ANSWER TO #49639 - APRIL 1996

The Coleco Adam keyboard will only work with the memory console. The memory console uses a 6801 master which can communicate with up to 16 peripheral devices including the keyboard. The keyboard also contains a 6801 and will not turn on

unless the correct data format is received. The baud rate is 62,500 and is derived by using the external 4.0 MHz crystal. The data format is non-return to zero with eight data bits. Communications protocol is set at half duplex bidirectional serial line. Tokens may be either one byte control message or a multiple byte data message. If you need a memory console, Adam house still sells them. Just call the 800 number on the bottom of your Coleco Adam keyboard.

Shon McCallum
Oakton, VA

ANSWER TO #4968 - APRIL 1996

Old style XT and clone keyboards had the keyboard microprocessor on the keyboard itself, and had a switch underneath the keyboard marked "XT or AT" whereby the user can switch modes to designate either an XT or AT. The AT keyboard placed the keyboard microprocessor on the motherboard of the computer. Older style and enhanced keyboard usually had a five-pin DIN cable termination, whereas newer style keyboards use the six-pin mini-DIN, or a modular type SDL (shielded data link) cable. Adapters are available at many computer retail outlets. An excellent source for old style XT keyboards is Alltech Electronics in California and they do advertise in *Nuts & Volts*; see ad on page 83 of the Apr. '96 issue.

Arthur Hazboun
Harbor City, CA

ANSWER TO #4962 - APRIL 1996

You mentioned that your cable company's box has a different sequence for channels 41, 42, and 43, compared to your Panasonic cable converter which contains the same channels on channels 95, 99, and 96. You are on a cable system that uses channel mapping for some of your channels. Whenever you try to use a cable-ready TV or a non-cable company box on a mapped system, you will experience this problem. The cable box that you rent has special software in it that assigns channel 41 as 95 and channel 43 as channel 96. Some companies do sell cable boxes that are mapped for some systems. You will just have to call around to find one.

The problem with the reception on channels 95 and 96 could be caused by a bad second connection. The Radio Shack 70-channel cable amplifiers are only good for 70 channels. You most likely are not amplifying the channels in the high 90s. The first thing you should do is to switch your Panasonic converter box with your cable company's box. Once your boxes are in different rooms, you should be able to see if the problem is with your Panasonic cable converter or the cable company's. If your Panasonic works fine in the other room and your cable company's box now experiences problems on channels 41 and 43, your problem is in the wiring. Make sure you are using RG-6 cable instead of RG-59. RG-6 will give you less signal loss. The problem could be in your signal splitter. Many signal splitters have problems with higher frequencies as excessive cable capaci-

tance and resistance increasingly cuts down the strength of the signal. I have found that the Monster Cable brand signal splitters even work better than the ones that the cable company uses.

Anonymous

ANSWER TO #49660 - APRIL 1996

The B&W 425 low-pass filter is rated for 1000 watts. It is designed for 34 MHz cutoff (it passes frequencies below 34 MHz with very low attenuation, but attenuates frequencies above that) with maximum attenuation at 52 MHz. If it appears to be undamaged, it is probably still functional, although the shunt capacitors may have been damaged by excessive RF voltage without obvious external signs. The best test method for someone who lacks a fully equipped lab is to feed some RF from a transmitter into the filter. Terminate the filter with a 50 ohm dummy load and check the SWR using a common SWR meter. Below 34 MHz, the SWR should be near 1:1. To test the filter's rejection of RF above 34 MHz, it could be inserted into the coaxial cable lead-in from a TV antenna, using appropriate adapters. The TV signals should be noticeably attenuated by the filter.

Roger Leone
Vallejo, CA

ANSWER TO #49628 - APRIL 1996

The "video broadcasts" referred to are actually digital data transmissions generally called "CAD" or Computer Aided Dispatch. A variety of systems are available and each uses a different, proprietary format. There are no hobbyist receivers or decoders for these signals. It may be possible to build your own if you can obtain technical data on the system you're interested in, however before using it, you'd better consult a lawyer as it could violate the Electronic Communications Privacy Act of 1986. The frequencies these data broadcasts occupy are standard public service channels that are listed in publications such as Police Call. Usually you'll find data on the VHF voice channels that police departments freed up by shifting to trunked voice systems on higher frequencies.

G.R. Scott
Alexandria, VA

ANSWER TO #49658 - APRIL 1996

The right angle PCB D-Sub 15-pin connector is sold by Mouser Electronics 1-800-346-6873. The stock number for the plug (male) connector is 152-3315, the receptacle (female) stock number is 152-3415.

Arthur Hazboun
Harbor City, CA

ANSWER TO #49662 - APRIL 1996

There is a real simple way to make a PC find a keyboard during the power-on self-test. Connect the electronics from a keyboard to the keyboard input. Simply remove the electronics from an old keyboard. In many cases, the key switches simply unplug from the electronic PC board. (The electronics board is usually not very big.) Place the electronics in a small plastic project box and place the project box inside the PC. Run the keyboard connector from the electronics out one of the unused card slot openings on the back

of the PC and plug it into the keyboard connector. If you wish, you may cut a small notch in the blank cover plate just big enough to allow the cable to run through and replace the plate. Then plug the keyboard cable into the keyboard connector. The PC will now find a keyboard during the power-on self-test.

Tim Naami
Cary, IL

ANSWER TO #49610 - APRIL 1996

The GE Series One was manufactured by KOYO and sold under different names by several major manufacturers/suppliers. The KOYO SR21 was an equal to GE Series One, Texas Instruments Series 305, Siemens SIMATIC T1305, PLC Direct DL305. Any card that was available from GE or the other manufacturers mentioned are 100% compatible with each other. All cards should be available from PLC Direct at a great savings. They will send you a catalog FREE. Their phone number is 1-800-633-0405.

T. Slough
Ventura, CA

ANSWER TO #49644 - APRIL 1996

If you use Windows 3.1 or Windows 95 on your computer, it is relatively simple to handle French characters. Most Windows word processors, such as Word, allow you to construct foreign characters with a combination of key strokes such as CTRL, "^," and "A" pressed simultaneously to produce an "a" with an accent caret above it. If you would prefer these keys be assigned permanently to the keyboard, you can select the "French" option for keyboard layout under Windows. This selection is under the Control Panel's International icon in Windows 3.1. For DOS you can change the DOS "code pages" using the DOS commands such as "keyb," "country," "n/sfun." The procedures to do this are too complex to detail here and, in fact, occupy an entire chapter of the DOS manual. If you waded through this process, you'll get foreign characters in all DOS applications and can even use them in file names, etc. A simpler DOS approach is to use a program like Word Perfect for DOS which will handle foreign characters using a version of the "multiple key" approach outlined for Windows. Word Perfect will also do a better job of handling the printing of these characters on a wider variety of printers than relying solely on DOS.

G.R. Scott
Alexandria, VA

ANSWER TO #49638 - APRIL 1996

There are a couple of approaches to your remote video problem. One is a dedicated video digitizer and a modem. Such a system used to be available from MicroMint. They advertise in several publications, notably *Circuit Cellar* and *Ink*. A more flexible solution might be to use a video capture board on a remote PC to digitize the video at preset intervals, or using preset triggers, such as movement. You could then call in with a laptop, and pick up and display the file using either a landline phone or a cellular.

G.R. Scott
Alexandria, VA

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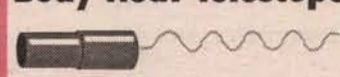


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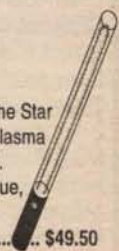
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Tiny computers run BASIC programs

BASIC Stamps are perfect for many applications, from controlling model trains to monitoring factory sensors. They have 8 or 16 I/O lines, which can be used for a variety of digital and analog purposes. And to keep life simple, they're programmed in BASIC. Our special "PBASIC" language includes familiar instructions, such as GOTO, FOR...NEXT, and IF...THEN, as well as instructions for serial I/O, button debounce, DTMF tone generation, etc.

The BASIC Stamp Programming Package contains everything you need to program Stamps using your PC. The package includes our editor software, programming cables, manuals, application notes, and free technical support. The package is available for \$99; Stamps and carrier boards must be purchased separately.

Also available at
Digi-Key
(800-344-4539)
and
Jameco
(800-831-4242)



XOUT *

Generates standard X-10 powerline control signals using two I/O pins and an inexpensive TTL-to-AC convertor module. Signals are received by small modules that control lights and appliances. Receiver modules are available from Parallax, Radio Shack, and other convenient sources.



BS2-IC Module
(FaxBack #6002)

* Only available on the Stamp II.

SHIFTOUT *

Uses two pins to control common shift registers. Can be used as a means of controlling many devices without using too many pins.

74HC595

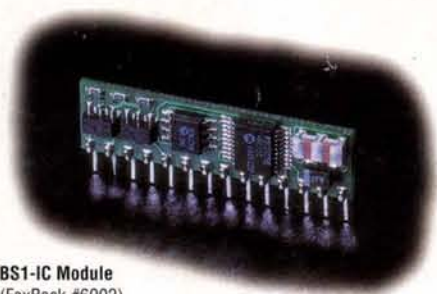
OUT1	1	16	VCC
OUT2	2	15	OUT0
OUT3	3	14	SERIN
OUT4	4	13	OE
OUT5	5	12	RCLK
OUT6	6	11	SCLK
OUT7	7	10	SCLR
GND	8	9	OUT7

BASIC Stamp II Module (BS2-IC)

16 general-purpose I/O lines
2048-byte program space (600 instructions)
\$49, \$69 with optional carrier board

BASIC Stamp I Module (BS1-IC)

8 general-purpose I/O lines
256-byte program space (80 instr.)
\$34, \$49 with optional carrier board



BS1-IC Module
(FaxBack #6002)




DTMFOUT *

Generates DTMF tones with just one I/O pin. Another related instruction, **FREQOUT**, generates one or two tones simultaneously. Each tone is programmable from 0-32767 Hz.



Marvin Green (first row, 2nd from left) uses BASIC Stamps in his Explorer Scouts robotics classes in Hillsboro, Oregon. These are some of his students with their Explorer-Bots, which are small Stamp-based robots that follow a light source while playing a tune.

PARALLAX 

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